GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1994

by

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United States Geological Survey

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CONVERSION FACTORS

Multiply	by	To obtain
acre-foot	1233	cubic meter
foot	0.3048	meter
inch	25.4	millimeter
mile	1.609	kilometer

Chemical concentration is given only in metric units--milligrams per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million.

DEFINITIONS OF TERMS

Acre-foot (AC-FT, acre-ft)—The quantity of water required to cover one acre to a depth of one foot; equal to 43,560 cubic feet or about 326,000 gallons or 1,233 cubic meters.

Aquifer—A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Artesian—Describes a well in which the water level stands above the top of the aquifer tapped by the well (confined). A flowing artesian well is one in which the water level is above the land surface.

Dissolved—Material in a representative water sample that passes through a 0.45–micrometer membrane filter. This is a convenient operational definition used by Federal agencies that collect water data. Determinations of "dissolved" constituents are made on subsamples of the filtrate.

Land-surface datum (lsd)—A datum plane that is approximately at land surface at each ground-water observation well.

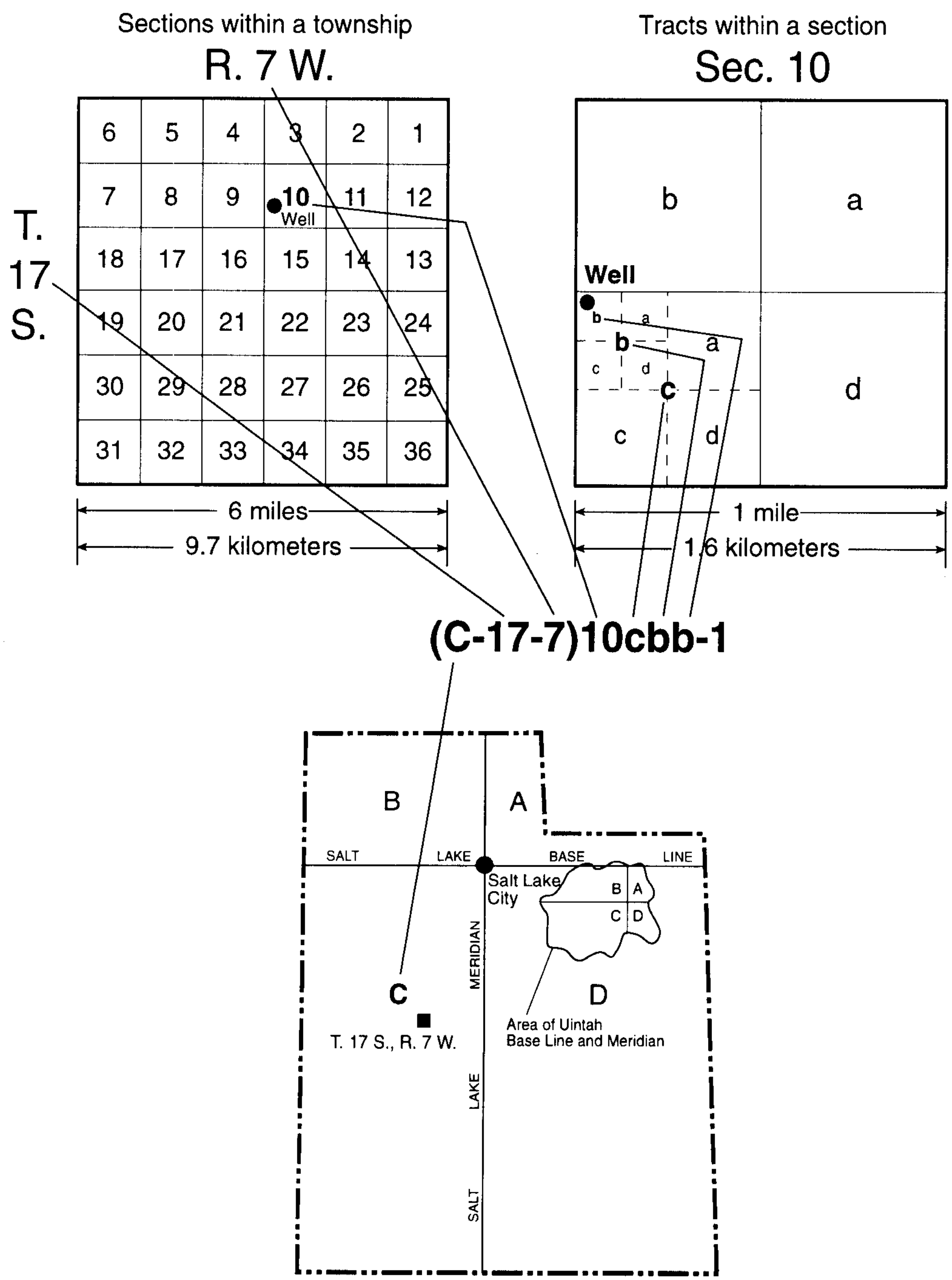
Milligrams per liter (MG/L, mg/L)—A unit for expressing the concentration of chemical constituents in solution. Milligrams per liter represents the mass of solute per unit volume (liter) of water.

Specific conductance—A measure of the ability of water to conduct an electrical current. It is expressed in microsiemens per centimeter at 25° Celsius. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids content of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is about 65 percent of the specific conductance (in microsiemens). This relation is not constant in water from one well or stream to another, and it may vary for the same source with changes in the composition of the water.

Cumulative departure from average annual precipitation—A graph of the departure or difference between the average annual precipitation and the value of precipitation for each year, plotted cumulatively. A cumulative plot is generated by adding the departure from average precipitation for the current year to the sum of departure values for all previous years in the period of record. A positive departure, or above-average precipitation, for a year results in a graph segment trending upward; a negative departure results in a graph segment trending downward. A generally downward graph for a period of years represents a period of generally below-average precipitation, which commonly causes and correlates with declining water levels in wells. Likewise, a generally upward graph for a period of years represents a period of above-average precipitation, which commonly causes and correlates with rising water levels in wells. However, increases or decreases in withdrawals of ground water from wells also affect water levels and can change or eliminate the correlation between water levels in wells and the graph of cumulative departure from average precipitation.

WELL-NUMBERING SYSTEM

The well-numbering system used in Utah is based on the U.S. Bureau of Land Management's system of land subdivision. The well-numbering system is familiar to most water users in Utah, and the well number shows the location of the well by quadrant, township, range, section, and position within the section. Well numbers for most of the state are derived from the Salt Lake Base Line and the Salt Lake Meridian. Well numbers for wells located inside the area of the Uintah Base Line and Meridian are designated in the same manner as those based on the Salt Lake Base Line and Meridian, with the addition of the "U" preceding the parentheses. The numbering system is illustrated below.



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INTRODUCTION

This is the thirty-first in a series of annual reports that describe ground-water conditions in Utah. Reports in the series, published cooperatively by the U.S. Geological Survey and the Utah Division of Water Resources, provide data to enable interested parties to keep abreast of changing ground-water conditions.

This report, like the others in the series, contains information on well construction, ground-water withdrawals from wells, water-level changes, related changes in precipitation and streamflow, and chemical quality of water. Supplementary data such as maps showing water-level contours are included in reports of this series only for those years or areas for which applicable data are available and are important to a discussion of changing ground-water conditions.

The report includes individual discussions of selected major areas of ground-water development in the State for the calendar year 1993. Water-level fluctuations and selected related data, however, are described from the spring of 1989 to the spring of 1994. Much of the data used in the report were collected by the U.S. Geological Survey in cooperation with the Divisions of Water Rights and Water Resources, Utah Department of Natural Resources.

The following reports dealing with ground water in the State were printed by the U.S. Geological Survey, printed by cooperating agencies, or published in conference proceedings during 1993:

Ground-water conditions in Utah, spring of 1993, by D.M. Batty, D.V. Allen, and others, Utah Division of Water Resources Cooperative Investigations Report No. 33.

Hydrology of Cache Valley, Cache County, Utah, and adjacent part of Idaho, with emphasis on simulation of ground-water flow, by K.A. Kariya, M.D. Roark, and K.M. Hanson, Utah Department of Natural Resources Technical Publication No. 108.

Ground-water hydrology of the upper Sevier River basin, south-central Utah, and simulation of ground-water flow in the valley-fill aquifer in Panguitch Valley, by S.A. Thiros and W.C. Brothers, Utah Department of Natural Resources Technical Publication No. 102.

Maps showing recharge areas and quality of ground water for the Navajo aquifer, western Washington County, Utah, by G.W. Freethey, U.S. Geological Survey Water-Resources Investigations Report 92-4160.

UTAH'S GROUND-WATER RESERVOIRS

Small quantities of ground water can be obtained from wells throughout much of Utah, but large supplies that are of suitable chemical quality for irrigation, public supply, or industrial use generally can be obtained only in specific areas. The major areas of ground-water development discussed in this report are shown in figure 1 and named in table 1. Relatively few wells outside of these areas yield large supplies of water of good chemical quality for the uses listed above, although some of the basins in western Utah and many areas in eastern Utah have not been explored sufficiently to determine their potential for ground-water development.

About 2 percent of the wells in Utah obtain water from consolidated rocks. The consolidated rocks that yield the most water are lava flows, such as basalt, which contain interconnected vesicular openings, fractures, or permeable weathered zones at the tops of flows; limestone, which contains fractures or other openings enlarged by solution; and sandstone, which contains open fractures. Most of the wells that penetrate consolidated rocks are in the eastern and southern parts of the State in areas where water supplies cannot be obtained readily from unconsolidated deposits.

About 98 percent of the wells in Utah withdraw water from unconsolidated deposits. These deposits may consist of boulders, gravel, sand, silt, or clay, or a mixture of some or all of these materials. Wells obtain the largest yields from the coarser materials that are sorted into deposits of uniform grain size. Most wells that tap unconsolidated deposits are in large intermountain basins, which have been partly filled with rock material eroded from the adjacent mountains.

SUMMARY OF CONDITIONS

The estimated total withdrawal of water from wells in Utah during 1993 was about 793,000 acre-feet (table 2), which is about 135,000 acre-feet less than the estimate for 1992 and equal to the average annual withdrawal for 1983-92 (table 3). The average annual withdrawal during 1989-93, 888,000 acre-feet, was 153,000 acre-feet more than during the preceding five-year period, 1984-88 (table 2).

Withdrawals in 1993 for irrigation, industry, and public supply decreased, compared with 1992 totals, and withdrawals for domestic and stock use showed no change. Withdrawals for irrigation were about 509,000 acre-feet (table 2), a decrease of 59,000 acre-feet from 1992. Withdrawals for public supply were about 164,000 acre-feet, which is 59,000 acre-feet less than the estimate for 1992. Withdrawals for industrial use were about 61,000 acre-feet, which is 14,000 acre-feet less than the 1992 estimate, and the 62,000 acre-feet withdrawn in 1993 for domestic and stock use is the same as the quantity for 1992.

In 12 of the 16 major areas of ground-water development referred to in this report (table 2), ground-water withdrawals decreased from 1992 to 1993. These areas include Curlew, Cache, East Shore, Salt Lake, Tooele, Utah and Goshen, Juab, Sevier Desert, Cedar Valley (Iron County), Parowan, Central Virgin River, and "other areas." Withdrawals in central Sevier Valley remained the same in 1993 as in 1992. Withdrawals in 1993 in the Pahvant Valley, Milford, and Beryl-Enterprise areas were greater than the estimated withdrawals for 1992.

Withdrawals during 1993 in 9 of the 16 areas exceeded the 1983-92 average annual withdrawals for each area. The average annual withdrawals during 1989-93 for 13 of the 16 areas also exceeded the average annual withdrawals for the preceding five-year period, 1984-88. The average annual withdrawal of 121,000 acre-feet in Utah and Goshen Valleys during 1989-93 is 29,000 acre-feet more than the average annual withdrawal for 1984-88. The average annual withdrawal of 80,000 acre-feet in the Beryl-Enterprise area during 1989-93 is 15,000 acre-feet less than the average annual withdrawal for 1984-88.

The quantity of water withdrawn from wells is related to demand and availability of water from other sources, which in turn are related partly to local climatic conditions. Calendar year 1989 was the second year of generally less-than-average precipitation in Utah after six years of greater-than-average precipitation (National Oceanic and Atmospheric Administration, 1993-94). The trend of less-than-average precipitation continued through 1992, before conditions improved with greater-than-average precipitation statewide in 1993. Of the 32 weather stations throughout Utah for which average annual precipitation values and graphs of cumulative departure from the average annual precipitation are included in this report, only two stations, Grouse Creek and Loa, recorded precipitation in 1993 that was less than the long-term average annual value. The largest positive departure from average precipitation in 1993 was the 6.57 inches above the average recorded at Pineview Dam near Ogden. Both negative departures in 1993 were 0.17 inch less than the long-term average.

Average annual precipitation during 1989-93 was less than the preceding five-year period, 1984-88, at 29 of the 32 weather stations included in this report. The average difference between the five-year periods at those 29 stations is 2.23 inches. The average annual precipitation during 1989-93 at Heber, Laketown, and Woodruff averaged 0.71 inch more than the average amount for 1984-88.

The generally less-than-average precipitation during 1989-93, as compared with 1984-88, resulted in less recharge to the ground-water reservoirs. The combined effect of reduced recharge and increased withdrawals, primarily for irrigation and public supply, resulted in declines in parts of all of the major areas of ground-water development in the State from the spring of 1989 to the spring of 1994. However, the generally Statewide greater-than-average precipitation during 1993, coupled with significantly reduced withdrawals during 1993, may have resulted in large water-level rises in parts of the East Shore area, Salt Lake Valley, and the northern part of Utah Valley from the spring of 1989 to the spring of 1994. No rises in water levels were observed from March 1989 to March 1994 in Curlew, Sevier Desert (shallow artesian aquifer) Cedar (Iron County), and Parowan Valleys.

The total number of wells constructed during 1993, 1,177 (table 2), taken from reports by well drillers filed with the Utah Division of Water Rights, is 75 more than was reported for 1992 and 104 less than was reported in 1991. Of the 1,177 wells constructed in 1993, 596 were for new appropriations of ground water and 61 were replacement wells. The remaining 520 wells include test and monitoring wells. Fifty-one large-diameter wells (12 inches or more), mostly used for withdrawal of water for public supply, irrigation, and industrial use, were constructed in 1993.

The areas of ground-water development specifically referred to in this report are shown in table 1. Information about well construction and withdrawal of water from wells in Utah for four major use categories during 1993 is given in table 2. Total annual withdrawals from wells in the major areas of ground-water development in Utah for 1983-92 are shown in table 3.

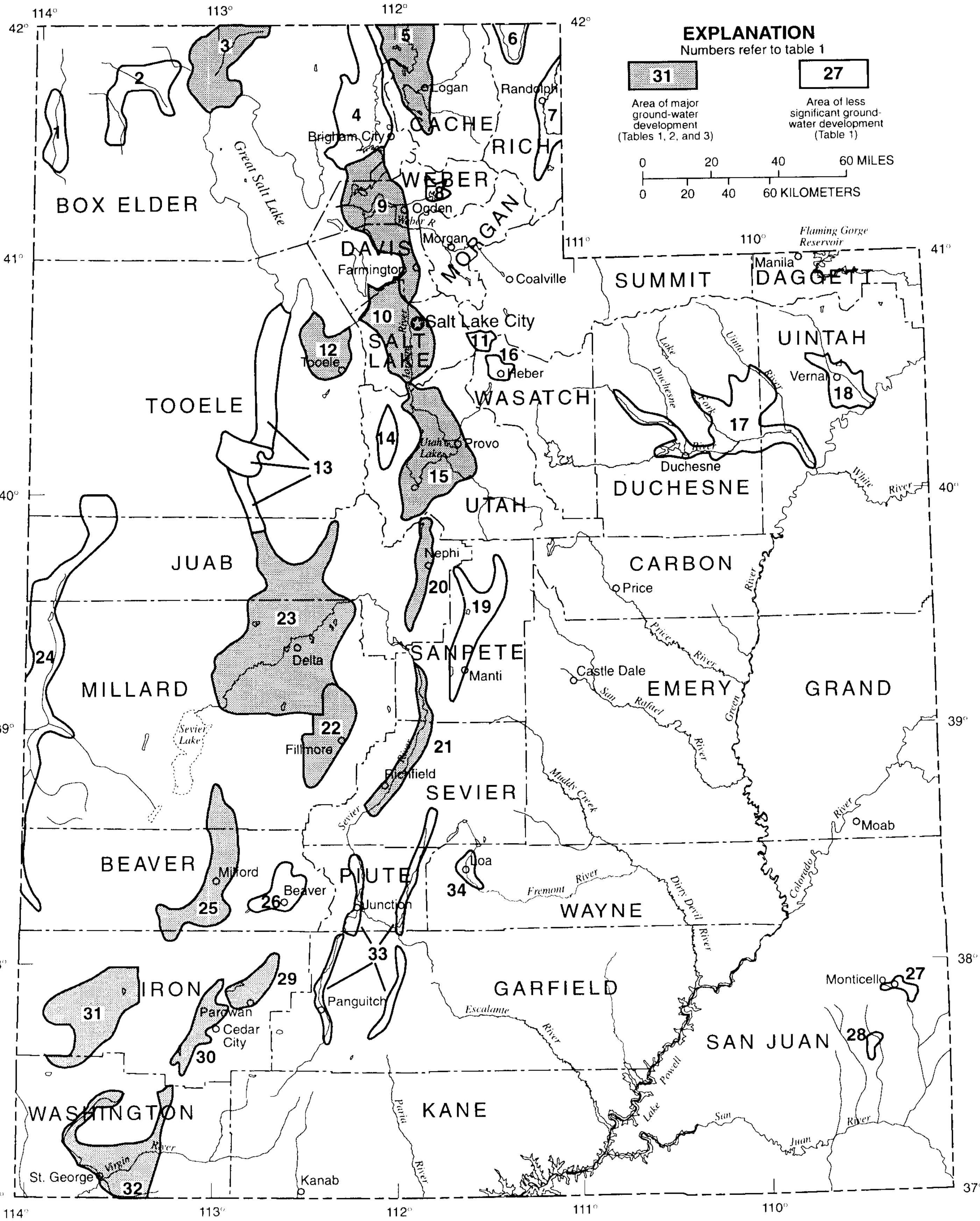


Figure 1. Areas of ground-water development in Utah specifically referred to in this report.

Table 1. Areas of ground-water development in Utah specifically referred to in this report

Number in figure 1	Area	Principal type of water-bearing rocks
1	Grouse Creek Valley	Unconsolidated.
2	Park Valley	Do.
3	Curlew Valley	Unconsolidated and consolidated.
4	Malad-lower Bear River valley	Unconsolidated.
5	Cache Valley	Do.
6	Bear Lake valley	Do.
7	Upper Bear River valley	Do.
8	Ogden Valley	Do.
9	East Shore area	Do.
10	Salt Lake Valley	Do.
11	Park City area	Unconsolidated and consolidated.
12	Tooele Valley	Unconsolidated.
13	Dugway area	Do.
	Skull Valley	Do.
	Old River Bed	Do.
14	Cedar Valley, Utah County	Do.
15	Utah and Goshen Valleys	Do.
16	Heber Valley	Do.
17	Duchesne River area	Unconsolidated and consolidated.
18	Vernal area	Do.
19	Sanpete Valley	Do.
20	Juab Valley	Unconsolidated.
21	Central Sevier Valley	Do.
22	Pahvant Valley	Do.
23	Sevier Desert	Unconsolidated.
24	Snake Valley	Do.
25	Milford area	Do.
26	Beaver Valley	Do.
27	Monticello area	Consolidated.
28	Blanding area	Do.
29	Parowan Valley	Unconsolidated and consolidated.
30	Cedar Valley, Iron County	Unconsolidated.
31	Beryl-Enterprise area	Do.
32	Central Virgin River area	Unconsolidated and consolidated.
33	Upper Sevier Valleys	Unconsolidated.
34	Upper Fremont River Valley	Unconsolidated and consolidated.

Table 2. Number of wells constructed and withdrawal of water from wells in Utah

Number of wells constructed in 1993—Data provided by Utah Department of Natural Resources, Division of Water Rights. Includes test wells and replacement wells.
Diameter of 12 inches or more—Constructed for irrigation, industry, or public supply.
Estimated withdrawals from wells—
1992 total: From Batty and others (1993, table 2), as revised.
1984-88 and 1989-93 average: Calculated from previous reports of this series and also include some previously unpublished revisions.

	Number in figure 1	Number of wells constructed in 1993		Estimated withdrawals from wells (acre-feet)							
				1993					1992	1984-88	1989-93
		Total	Diameter of 12 inches or more	Irrigation	Industry	Public supply	Domestic and stock	Total (rounded)	total (rounded)	average (rounded)	average (rounded)
Curlew Valley	3	4	2	35,000	0	50	50	35,000	44,000	27,000	38,000
Cache Valley	5	49	5	10,000	6,600	5,100	1,800	23,000	36,000	25,000	30,000
East Shore area	9	132	3	[1]25,000	6,800	19,700	5,000	56,000	59,000	63,000	62,000
Salt Lake Valley	10	194	15	2,400	[2]22,000	68,800	23,000	116,000	138,000	121,000	138,000
Tooele Valley	11	114	23	[1]18,000	350	3,650	300	22,000	30,000	23,000	28,000
Utah and Goshen Valleys	14	88	6	43,600	4,000	20,700	20,600	89,000	141,000	92,000	121,000
Juab Valley	19	1	0	19,200	0	[3]430	350	20,000	29,000	14,000	26,000
Sevier Desert	22	12	2	26,000	3,000	2,100	300	31,000	33,000	13,000	30,000
Central Sevier Valley	20	[4]33	2	15,700	100	800	2,200	19,000	19,000	17,000	18,000
Pahvant Valley	21	5	2	86,400	0	460	100	87,000	86,000	60,000	83,000
Cedar Valley, Iron County	29	38	12	27,800	450	4,300	400	33,000	34,000	21,000	32,000
Parowan Valley	28	3	1	[5]27,000	0	550	150	28,000	31,000	23,000	30,000
Escalante Valley											
Milford area	24	3	1	44,700	[6]4,000	1,100	250	50,000	42,000	42,000	48,000
Beryl-Enterprise area	30	35	14	76,400	600	400	750	78,000	72,000	95,000	80,000
Central Virgin River area	31	23	10	1,800	250	10,900	250	13,000	14,000	20,000	17,000
Other areas [7,8]		443	53	49,600	12,500	24,600	6,300	93,000	120,000	79,000	107,000
Totals (rounded)		[9]1,177	51	509,000	61,000	164,000	62,000	793,000	928,000	735,000	888,000

[1] Includes some domestic and stock use.
[2] Includes some use for air conditioning, about 30 percent of which is reinjected into the aquifer.
[3] Includes some industrial use.
[4] Includes wells constructed in upper Sevier Valley and upper Fremont River Valley.
[5] Includes some use for stock.
[6] Withdrawal for geothermal power generation. Approximately 99 percent was reinjected.
[7] Withdrawals are estimated minimum. See page 75 for withdrawal estimates for other areas.
[8] Includes withdrawals for upper Sevier Valley and upper Fremont River Valley that were included with central Sevier Valley in previous reports of this series.
[9] Includes 596 wells drilled for new appropriations of ground water and 61 replacement wells. Data from Division of Water Rights, Utah Department of Natural Resources.

Table 3. Total annual withdrawal of water from wells in major areas of ground-water development in Utah, 1983-92

[From previous reports of this series]

Area	Number in figure 1	Thousands of acre-feet 1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1983-92 average (rounded)
Curlew Valley	3	18	20	27	26	29	34	29	43	37	44	31
Cache Valley	5	20	21	22	23	26	33	30	32	29	36	27
East Shore area	9	43	49	67	66	67	68	61	65	68	59	61
Salt Lake Valley	10	110	102	110	104	122	165	157	143	135	138	129
Tooele Valley	12	22	23	22	21	22	26	27	33	30	30	26
Utah and Goshen Valleys	15	74	78	88	75	104	113	121	129	124	141	105
Juab Valley	20	6	6	11	10	22	22	28	27	25	29	19
Sevier Desert	23	8	10	13	11	15	15	17	34	34	33	19
Central Sevier Valley [1]	21	17	16	17	18	18	17	18	18	18	19	18
Pahvant Valley	22	42	42	62	60	66	71	82	88	74	86	67
Cedar Valley, Iron County	30	21	20	23	19	21	20	28	30	34	34	25
Parowan Valley	29	22	22	25	24	22	20	29	31	32	31	26
Escalante Valley												
Milford area	25	39	32	49	46	44	40	46	48	54	42	44
Beryl-Enterprise area	31	86	95	100	93	97	88	85	86	79	72	88
Central Virgin River area [2]	32	16	19	21	20	20	18	23	22	15	14	19
Other areas		56	68	81	72	79	95	100	111	111	120	89
Totals		600	623	738	688	774	[1]845	[1]881	[1]940	899	928	793

[1] Previously included upper Sevier and upper Fremont River valleys.
[2] Prior to 1984 included under "Other Areas".

MAJOR AREAS OF GROUND-WATER DEVELOPMENT

CURLEW VALLEY

by J.D. Sory

Withdrawal of water from wells in Curlew Valley in 1993 was approximately 35,000 acre-feet, a decrease of 9,000 acre-feet from the quantity reported for 1992 and 4,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for 1989-93 was 38,000 acre-feet, 11,000 acre-feet more than for the preceding five-year period, 1984-88. All of the increased withdrawals were for irrigation.

Water levels in Curlew Valley declined from March 1989 to March 1994 with the largest decline, about 16 feet, measured in a well approximately 10 miles west of Snowville (fig. 2). The declines are the result of increased withdrawals and decreased recharge from precipitation for 1989-93 compared with the previous five-year period. Precipitation at Grouse Creek during 1993 was 10.86 inches, 2.97 inches more than in 1992, and 0.18 inch less than the average precipitation for 1959-93. The average annual precipitation during 1989-93 was 9.09 inches, 2.34 inches less than the average annual precipitation for the preceding five-year period, 1984-88, and 1.95 inches less than the 1959-93 average.

The relation of water levels in two selected observation wells to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-15-9)28cbc-1, northwest of Snowville, is shown in figure 3. The hydrographs for wells (B-14-9)7bbb-1 in the irrigated area near Snowville and (B-12-11)16cdc-1 near the irrigated area of Kelton are representative of the ground-water levels in those areas, and show the effects of precipitation and the resulting recharge and withdrawals for irrigation.

The concentration of dissolved solids in water from well (B-15-9)28cbc-1 increased during 1974-93 from about 2,500 milligrams per liter to about 6,000 milligrams per liter. Two possible causes of this increase are movement of saline water toward the well because of water-level declines in the area and recharge from unconsumed irrigation water in which dissolved solids in the water have been concentrated by evaporation.

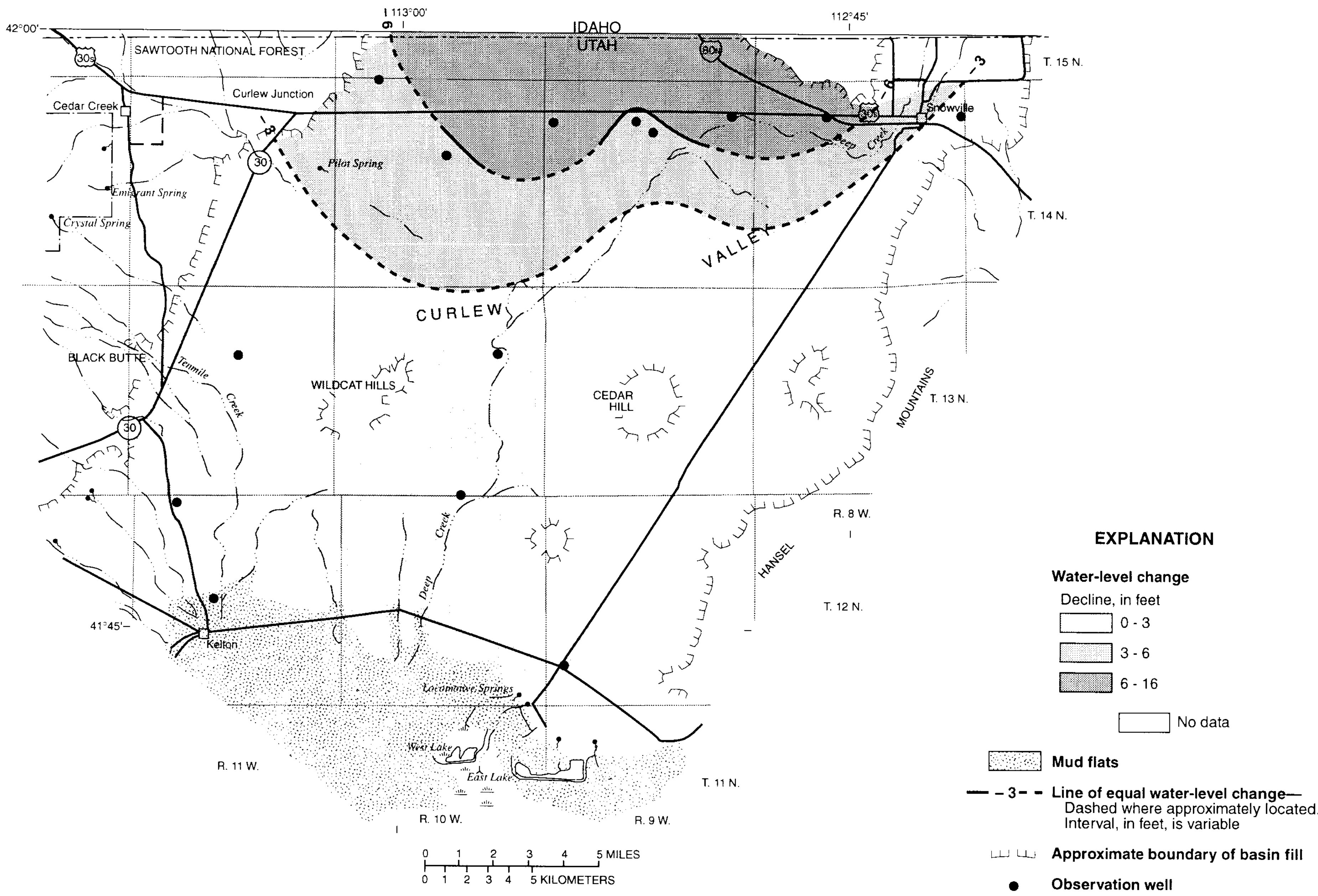


Figure 2. Map of Curlew Valley showing change of water levels from March 1989 to March 1994.

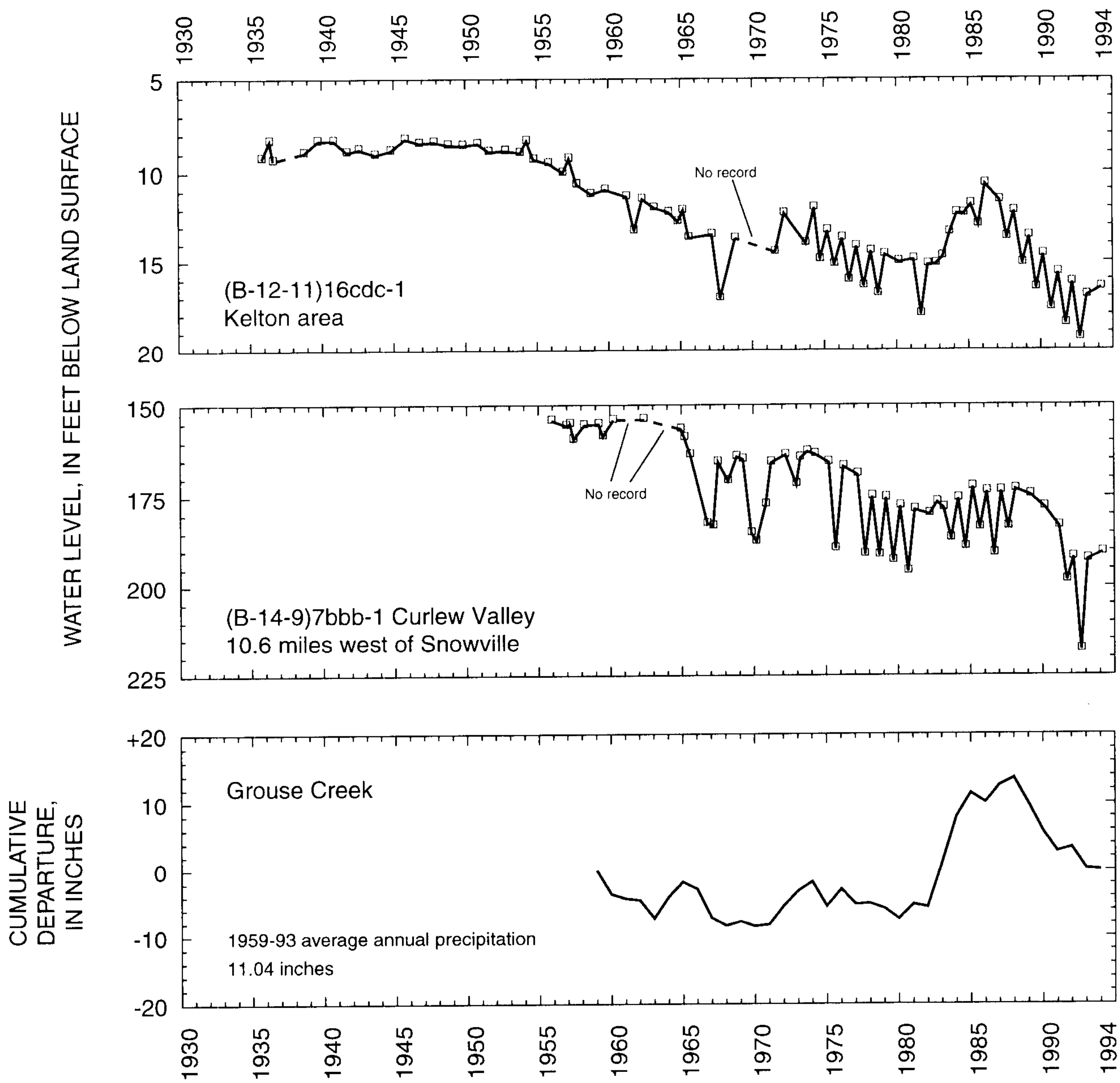


Figure 3. Relation of water levels in selected wells in Curlew Valley to cumulative departure from the average annual precipitation at Grouse Creek, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-15-9)28cbc-1.

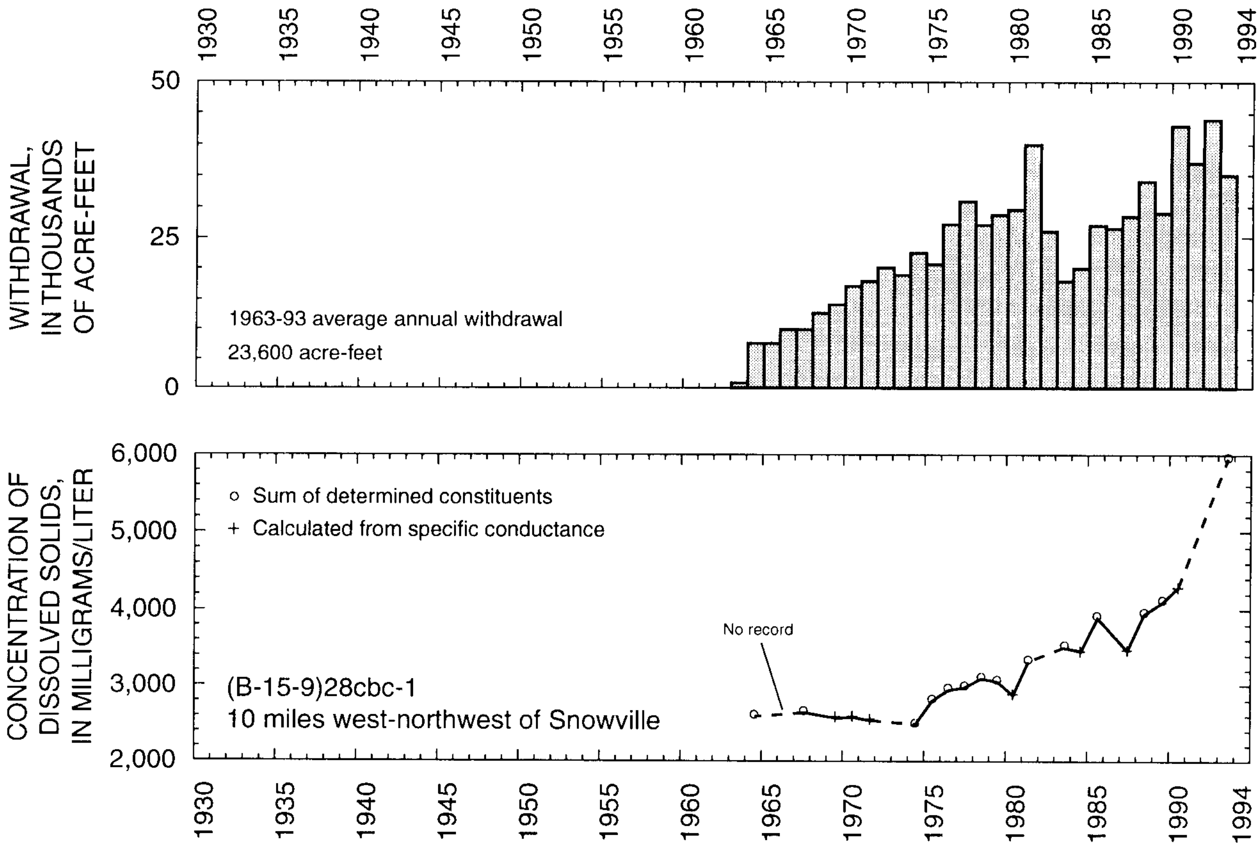


Figure 3. Relation of water levels in selected wells in Curlew Valley to cumulative departure from the average annual precipitation at Grouse Creek, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-15-9)28cbc-1—Continued.

CACHE VALLEY

by R.B. Garrett

Withdrawal of water from wells in Cache Valley in 1993 was approximately 23,000 acre-feet. This was 13,000 acre-feet less than was reported for 1992 and 4,000 acre-feet less than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for 1989-93 was 30,000 acre-feet, 5,000 acre-feet more than during the preceding five-year period, 1984-88. The decrease in withdrawals in 1993 was mostly because of decreased withdrawals for public supply and irrigation. Withdrawal for public supply was 5,100 acre-feet, 5,800 acre-feet less than the value for 1992. Withdrawal for irrigation during 1993 was about 10,000 acre-feet, approximately 6,100 acre-feet less than the quantity for 1992.

Water levels mostly declined from March 1989 to March 1994 along the west side of Cache Valley and mostly rose along the east side (fig. 4). Local areas of declines occurred along the east side of the valley near Richmond, Logan, and Hyrum, where pumpage for public supply and irrigation are greatest. The largest decline, 5.1 feet, was measured in a well in Cache Junction. The largest rise, 2.4 feet, was measured in a well about 2 miles north of Richmond. The rises probably were the result of above-average precipitation in 1993, which resulted in an increase in recharge and a decrease in withdrawals.

The relation of water levels in wells (A-12-1)29cab-1 and (A-13-1)29adc-1, to total discharge of the Logan River near Logan, to cumulative departure from the average annual precipitation at the Logan, Utah State University (USU) station, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (A-11-1)8dda-3 are shown in figure 5.

Total discharge of the Logan River (combined flow from the Logan River above State Dam, near Logan and Logan, Hyde Park, and Smithfield Canal at Head, near Logan) during 1993 was about 190,900 acre-feet, which is approximately 110,300 acre-feet more than the 80,600 acre-feet for 1992 and 105 percent of the 1941-93 average annual discharge.

The concentration of dissolved solids increased sharply from 1960 to 1961, and from 1961-90 has ranged between about 250 to about 310 milligrams per liter with no apparent trend. No data are available since 1990.

Annual precipitation at the Logan USU station was 20.25 inches in 1993. This was 6.64 inches more than the quantity reported for 1992, and 1.65 inches more than the average annual precipitation for 1941-93. The average precipitation for 1989-93 was 16.84 inches, 3.14 inches less than the average of 19.98 inches for the preceding five years, 1984-88.

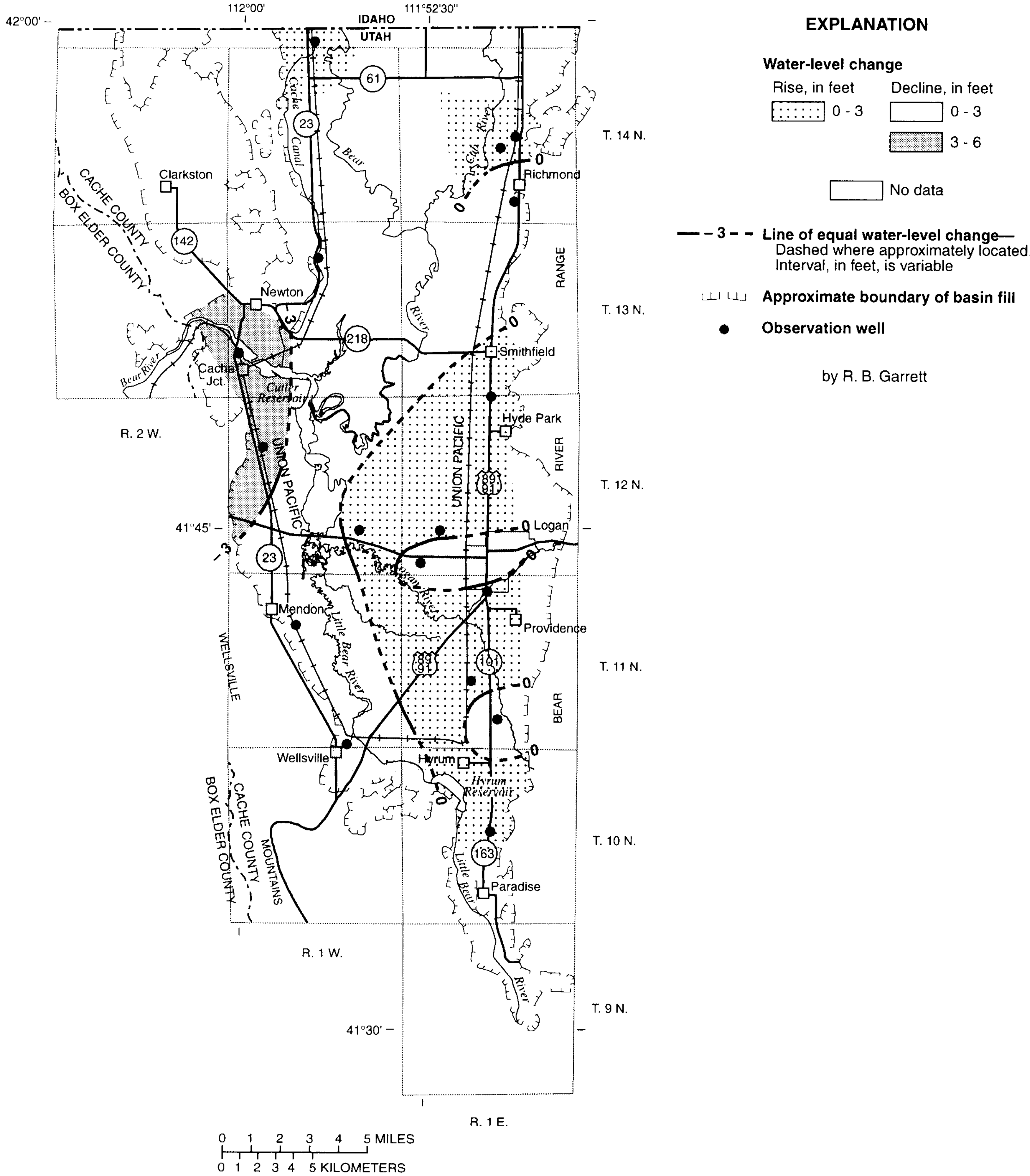


Figure 4. Map of Cache Valley showing change of water levels from March 1989 to March 1994.

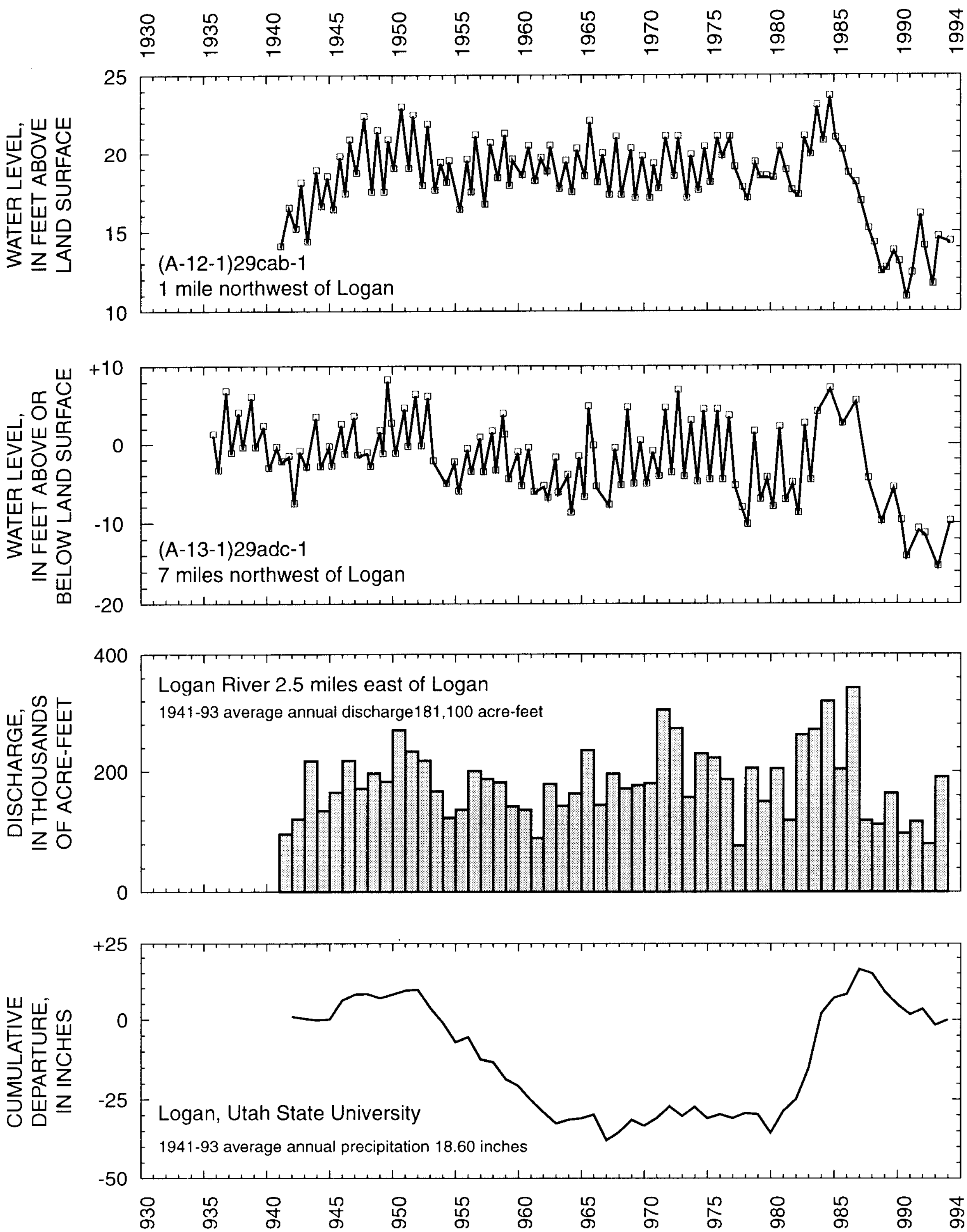


Figure 5. Relation of water levels in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from the average annual precipitation at Logan, Utah State University, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (A-11-1)8dda-3.

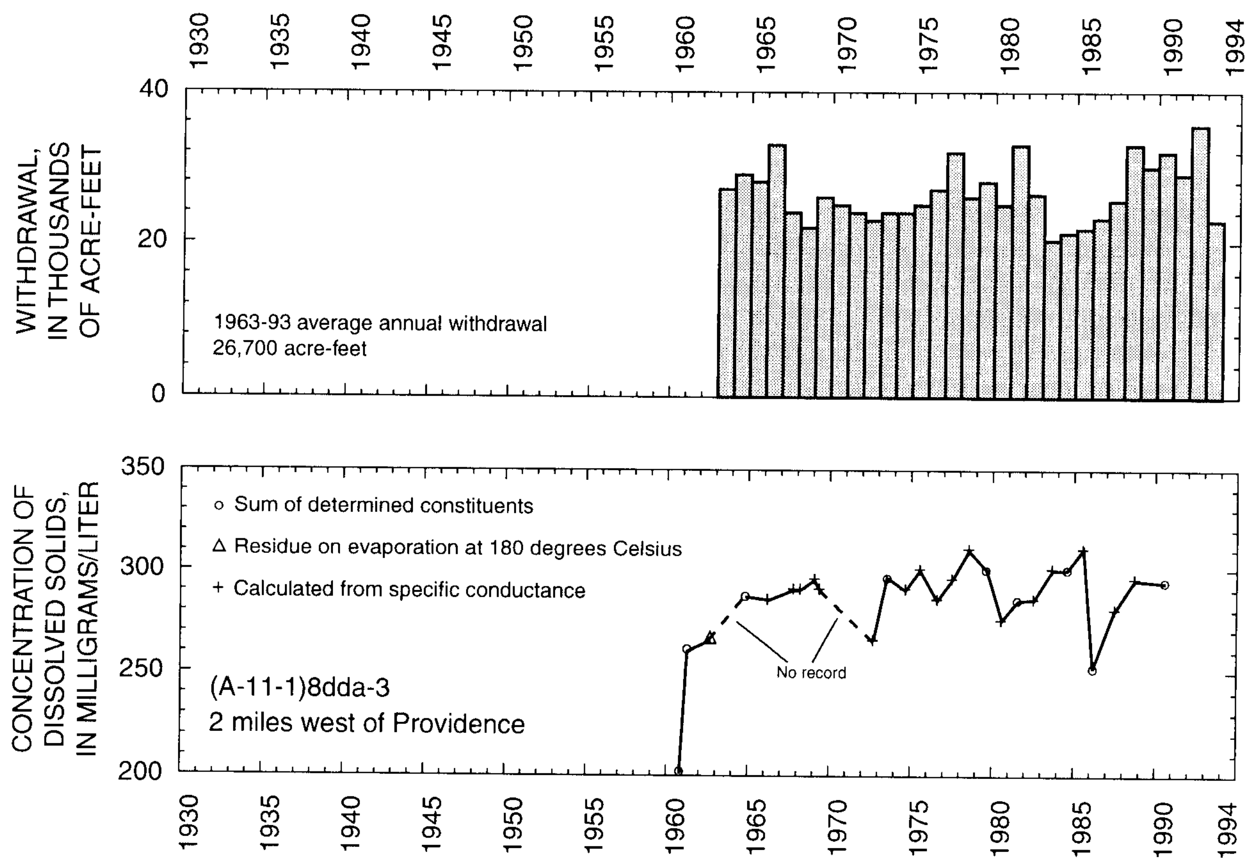


Figure 5. Relation of water levels in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from the average annual precipitation at Logan, Utah State University, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (A-11-1)8dda-3—Continued.

EAST SHORE AREA

by Carole B. Burden

Withdrawal of water from wells in the East Shore Area in 1993 was about 56,000 acre-feet, 3,000 acre-feet less than was reported for 1992 and 5,000 acre-feet less than the average annual withdrawal for 1983-92 (tables 2 and 3). Withdrawal for public supply was about 19,700 acre-feet, 2,500 acre-feet less than in 1992. Industrial withdrawal decreased during 1993 by 500 acre-feet to 6,800 acre-feet, and irrigation withdrawal increased 200 acre-feet to 25,000 acre-feet. The average annual withdrawal for 1989-93, 62,000 acre-feet, was 1,000 acre-feet less than for the preceding five-year period, 1984-88.

Water levels generally rose from March 1989 to March 1994 in most of the East Shore Area. The largest rise, 16.1 feet, occurred in a well in Ogden (fig. 6). The rise in water levels is probably the result of decreased withdrawals during 1989-93 compared with the preceding five-year period, 1984-88. Declines in water levels occurred in the northwest and the western edge of the area. The largest decline, about 15 feet, occurred in a well about 6 miles southwest of Willard. Declines were probably a result of increased local pumpage.

The relation of water levels in selected wells to cumulative departure from average annual precipitation at the Ogden Pioneer Powerhouse, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1 is shown in figure 7. Precipitation at the Ogden Pioneer Powerhouse in 1993 was 26.90 inches, 5.26 inches more than the average annual precipitation for 1937-93. The average annual precipitation for 1989-93, 20.97 inches, was 0.61 inch less than the average for the preceding five-year period, 1984-88.

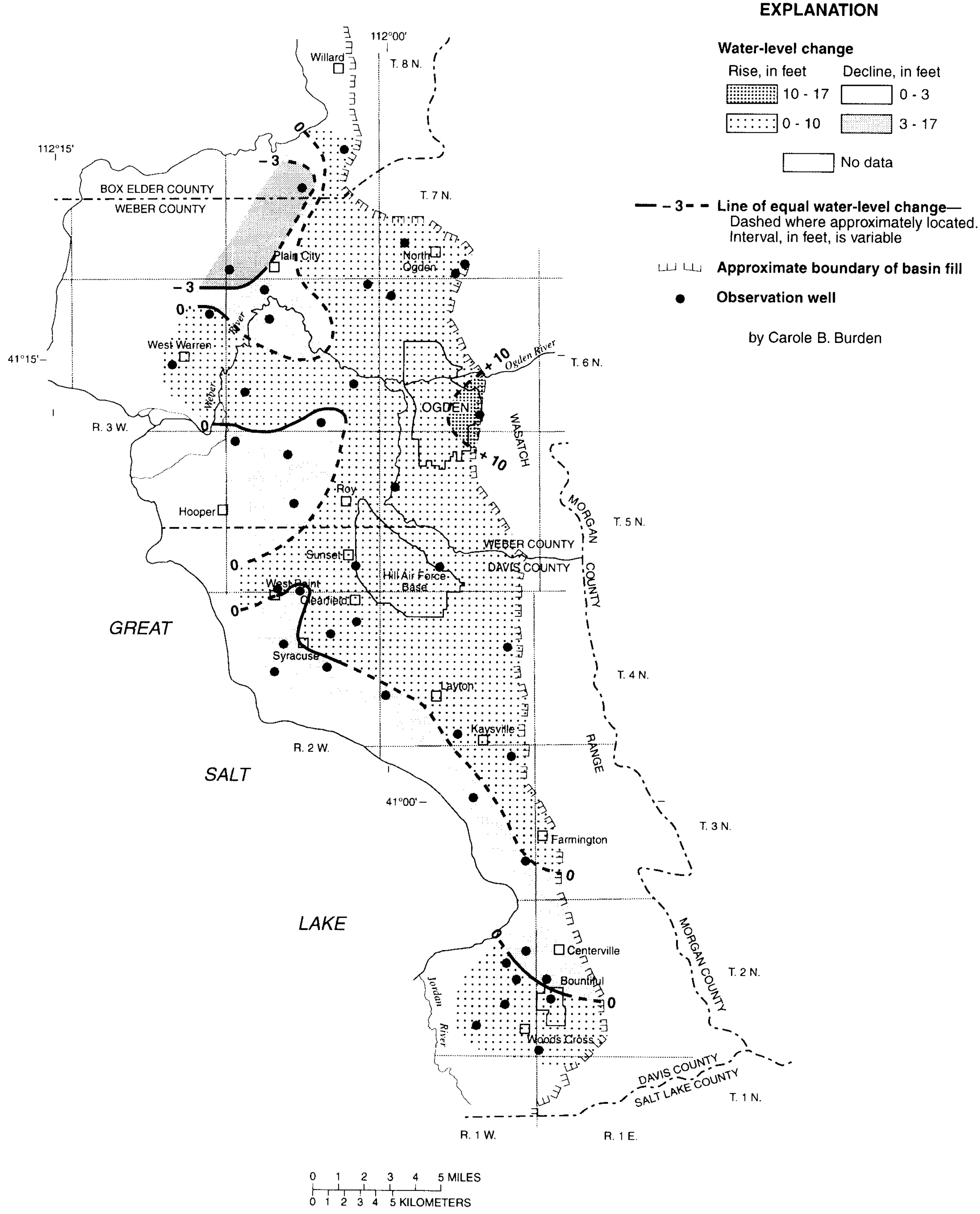


Figure 6. Map of the East Shore area showing change of water levels from March 1989 to March 1994.

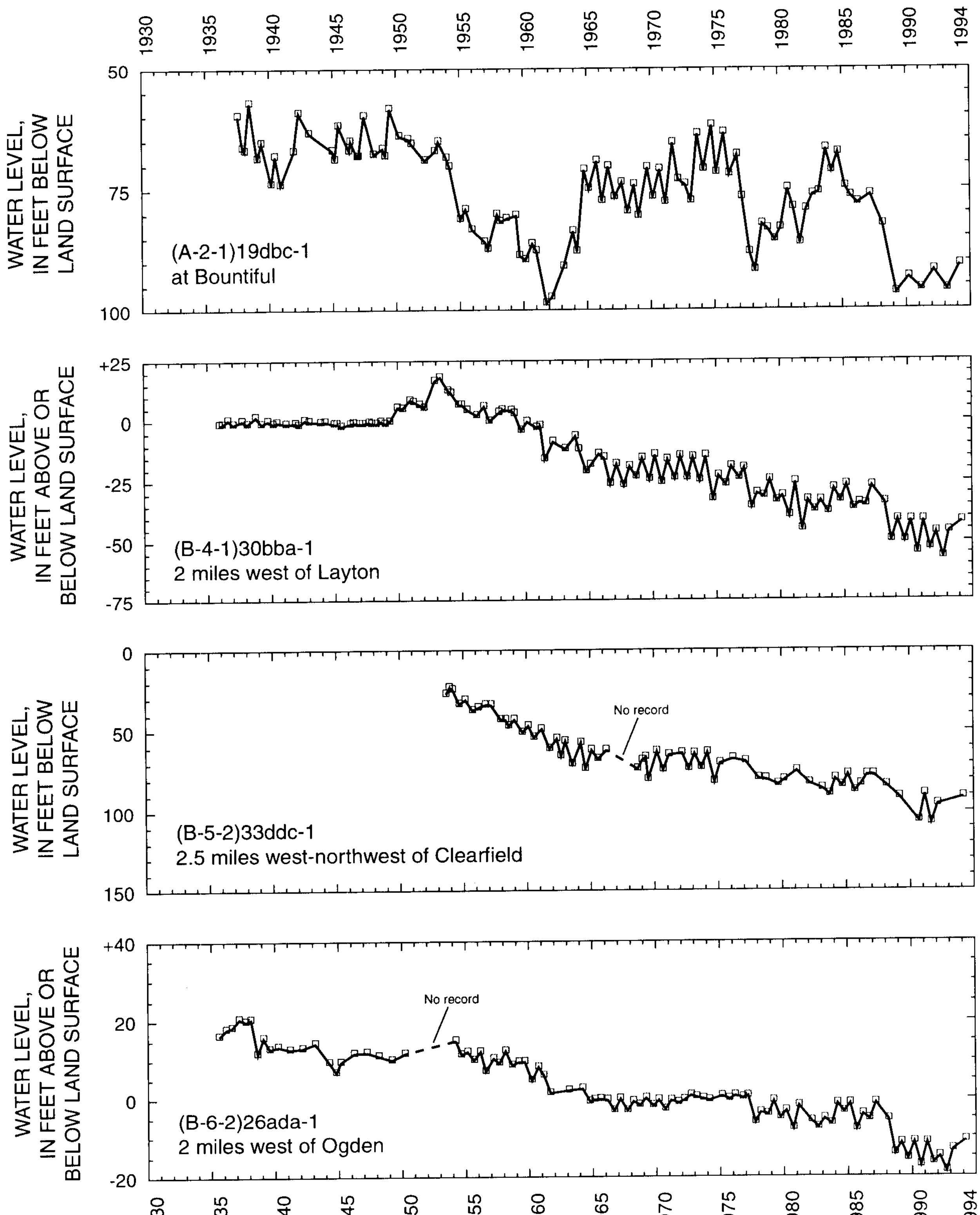


Figure 7. Relation of water levels in selected wells in the East Shore area to cumulative departure from the average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1.

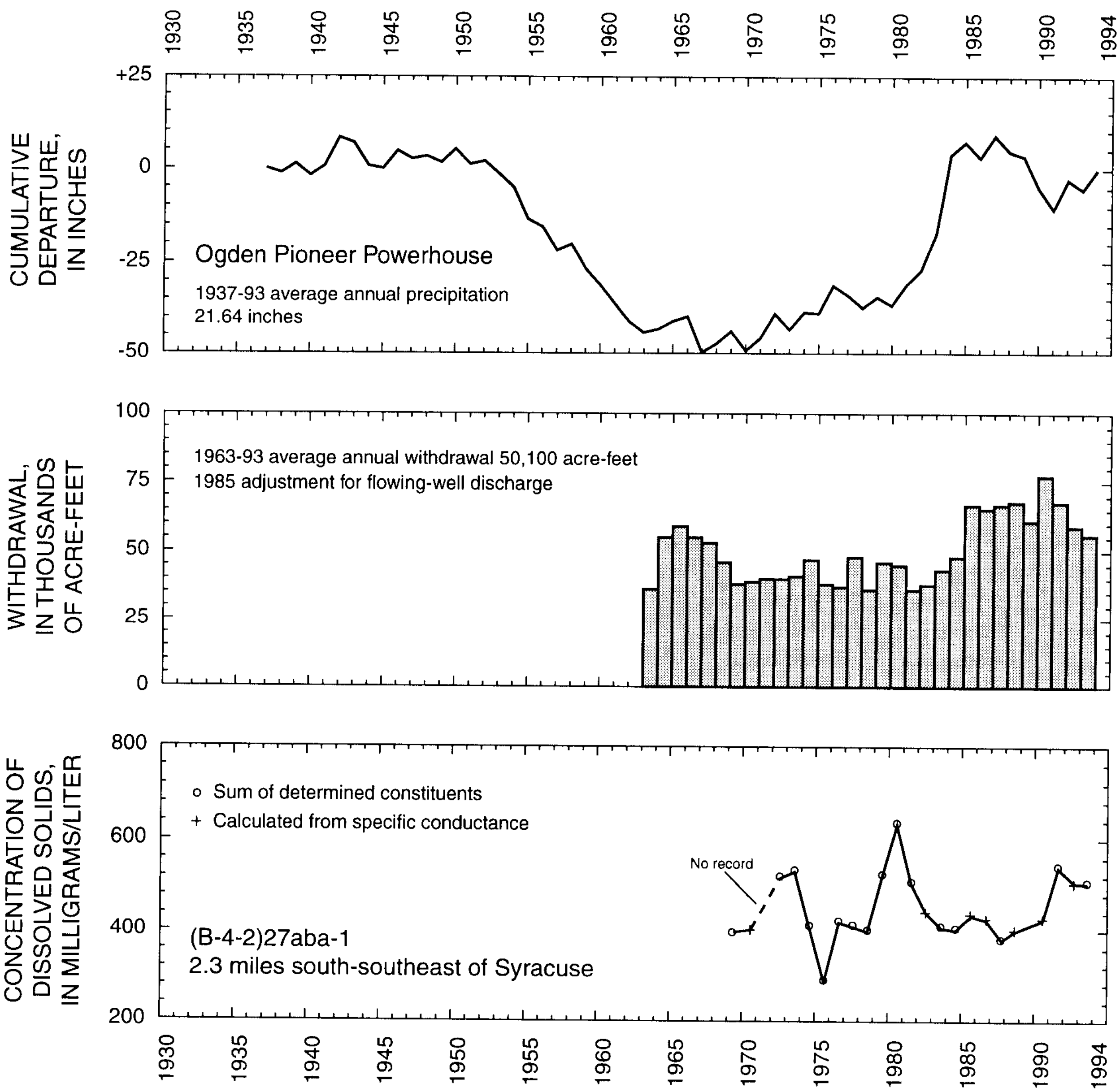


Figure 7. Relation of water levels in selected wells in the East Shore area to cumulative departure from the average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.

SALT LAKE VALLEY

by Carole B. Burden

Withdrawal of water from wells in Salt Lake Valley in 1993 was about 116,000 acre-feet, or about 22,000 acre-feet less than in 1992, and about 13,000 acre-feet less than the average annual withdrawal for 1983-92 (tables 2 and 3). Withdrawal for public supply was about 68,800 acre-feet, 17,200 acre-feet less than was reported in 1992. Withdrawal for industrial use in 1993 was 22,000 acre-feet, 2,900 acre-feet less than the quantity reported for 1992. The 1989-93 average annual withdrawal, 138,000 acre-feet, is 17,000 acre-feet more than the average for the preceding five-year period, 1984-88.

Water levels in the principal aquifers generally declined in most of Salt Lake Valley from February 1989 to February 1994 (fig. 8). The areas of greatest decline were southwest of Magna, and between Herriman and Riverton. Water level declines were probably the result of local increases in pumpage during 1993. Water-level rises occurred in the north, northeast and central parts of the valley. The largest rise, 13.0 feet, occurred in a well in Salt Lake City.

Estimated Salt Lake County population, total annual withdrawals from wells, annual withdrawals for public supply, and average annual precipitation at the Salt Lake City Weather Service Office (WSO) (International Airport) are shown in figure 9. Precipitation at the Salt Lake City WSO during 1993 was 18.87 inches, 3.77 inches more than the average annual precipitation for 1931-93. The average annual precipitation for 1989-93, 14.06 inches, was 1.88 inches less than the average for the previous five-year period, 1984-88.

The relation of water levels in selected wells completed in the principal aquifer to cumulative departure from the average annual precipitation at Silver Lake near Brighton, and the relation of water levels in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well are shown in figure 10. Precipitation at Silver Lake near Brighton was 48.01 inches in 1993, 5.51 inches more than the average annual precipitation for 1931-93. The average precipitation during 1989-93, 38.99 inches, was 3.55 inches less than the average for the preceding five-year period, 1984-88.

The chloride concentration from well (D-1-1)7abd-6 (located in Artesian Well Park in Salt Lake City and used by many people for drinking water) was 120 milligrams per liter in July 1993. This is 10 milligrams per liter less than was measured in 1992. Water levels in selected observation wells in the shallow unconfined aquifer and the principle aquifer in the northwestern part of the valley are shown in figure 11. The water level in the shallow well in Rose Park declined about 3.8 feet from February 1993 to February 1994. The water level in well (B-1-2)36baa-1, about 6 miles west of Salt Lake City near the International Center, rose about 1.1 feet from February 1993 to February 1994.

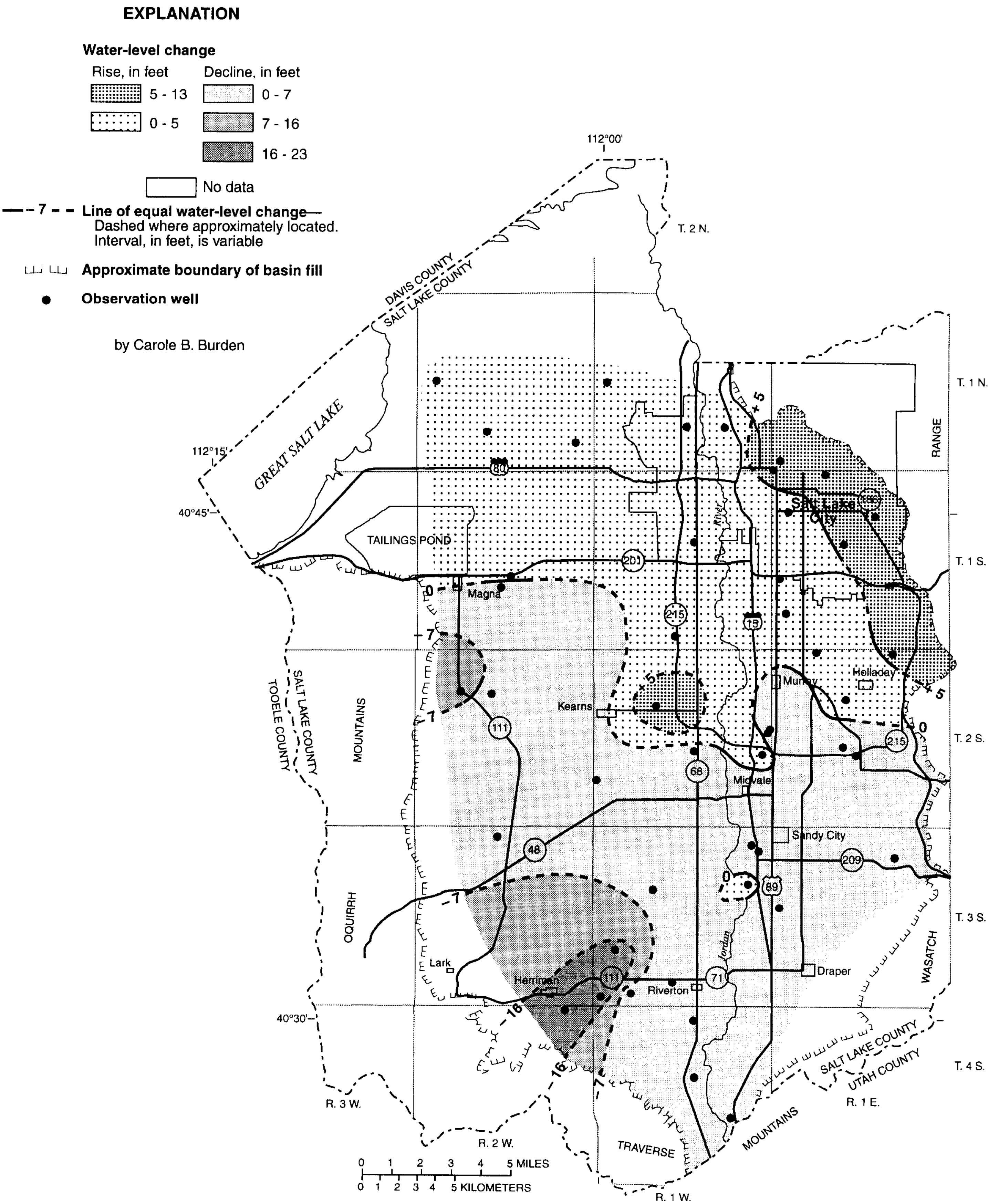


Figure 8. Map of the Salt Lake Valley showing change of water levels in the principal aquifer from February 1989 to February 1994.

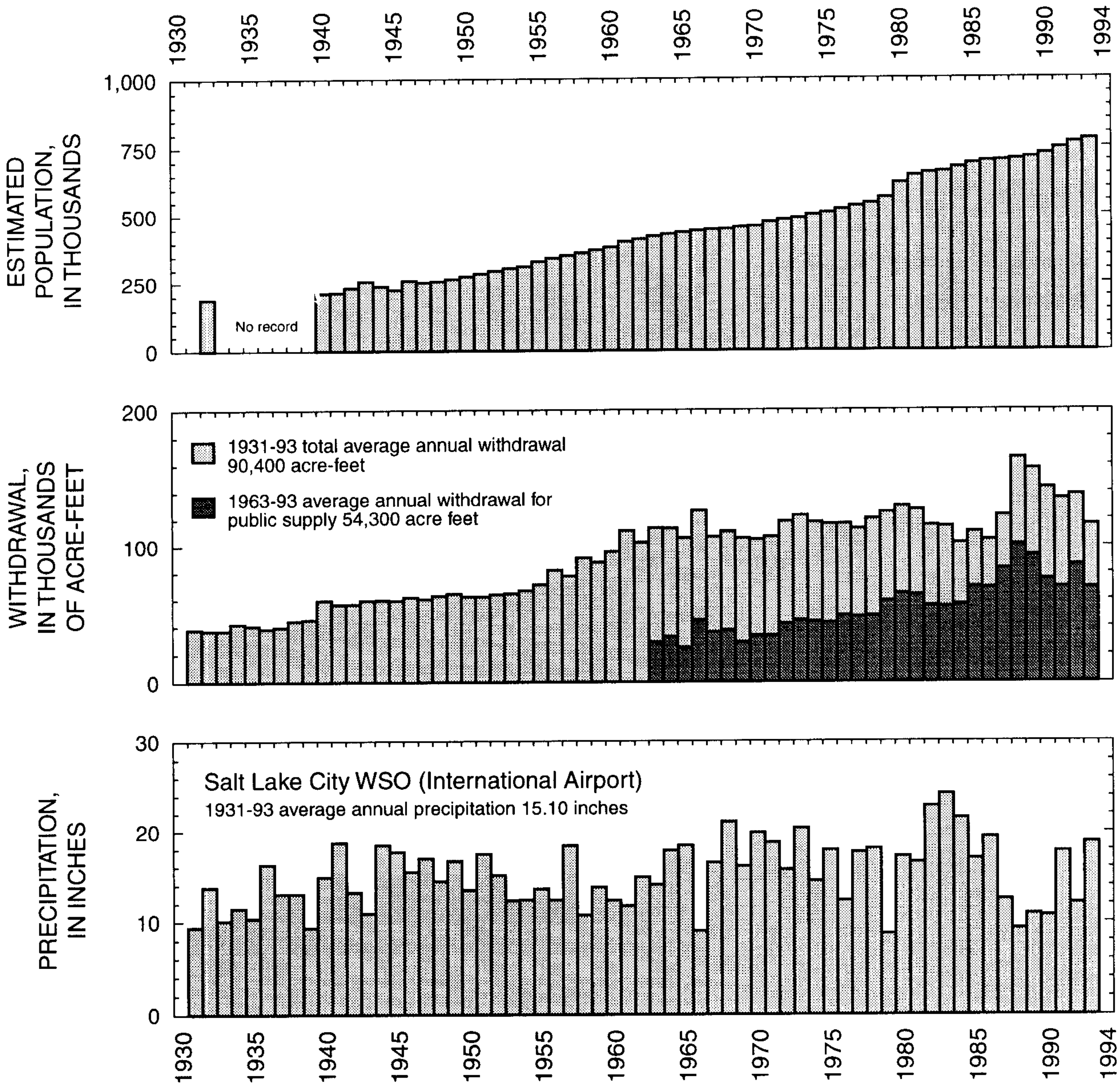


Figure 9. Estimated population of Salt Lake County, total annual withdrawals from wells and annual withdrawals for public supply, and average annual precipitation at Salt Lake City WSO (International Airport).

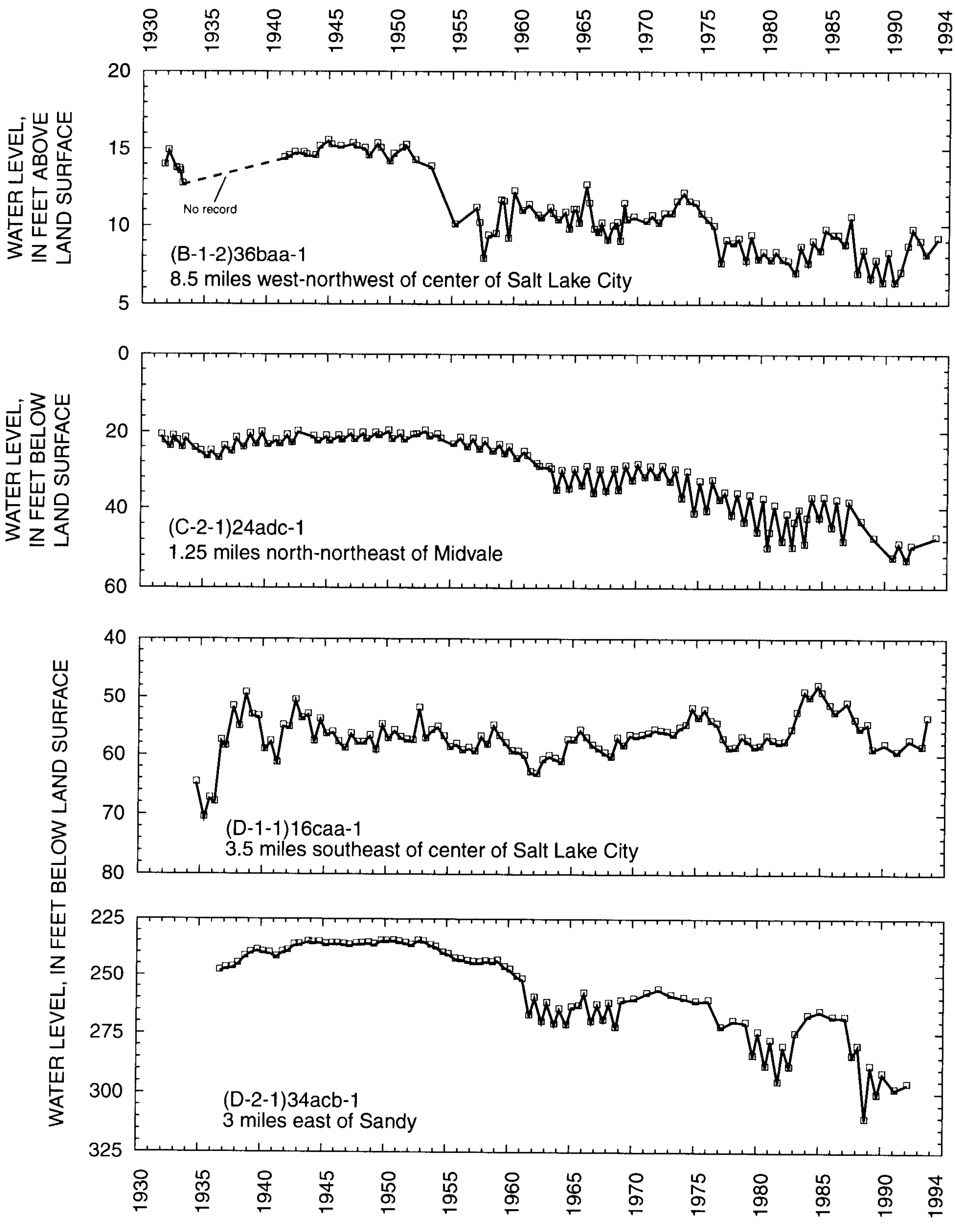


Figure 10. Relation of water levels in selected wells in the principal aquifer in Salt Lake Valley to cumulative departure from the average annual precipitation at Silver Lake Brighton, and relation of water levels in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well.

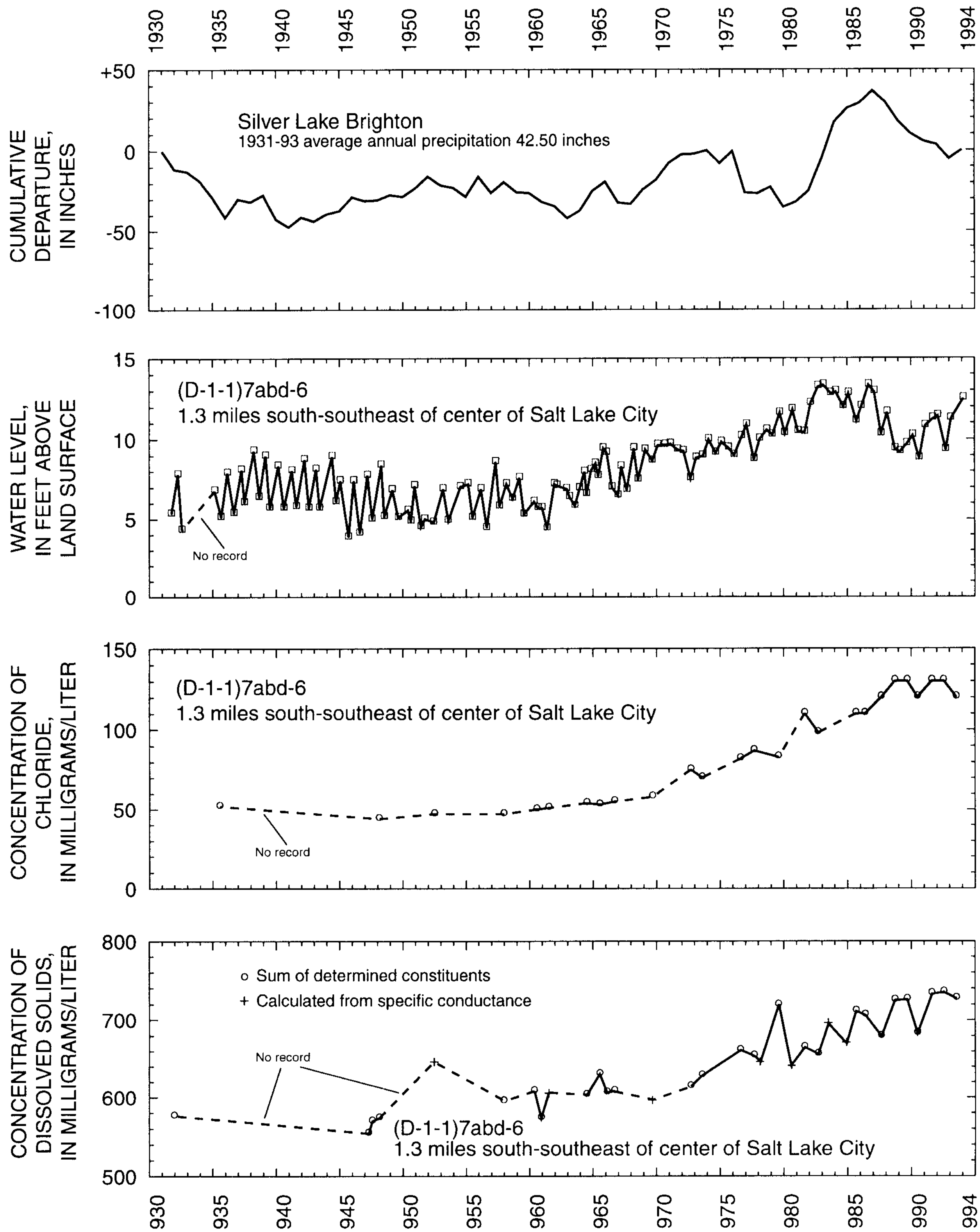
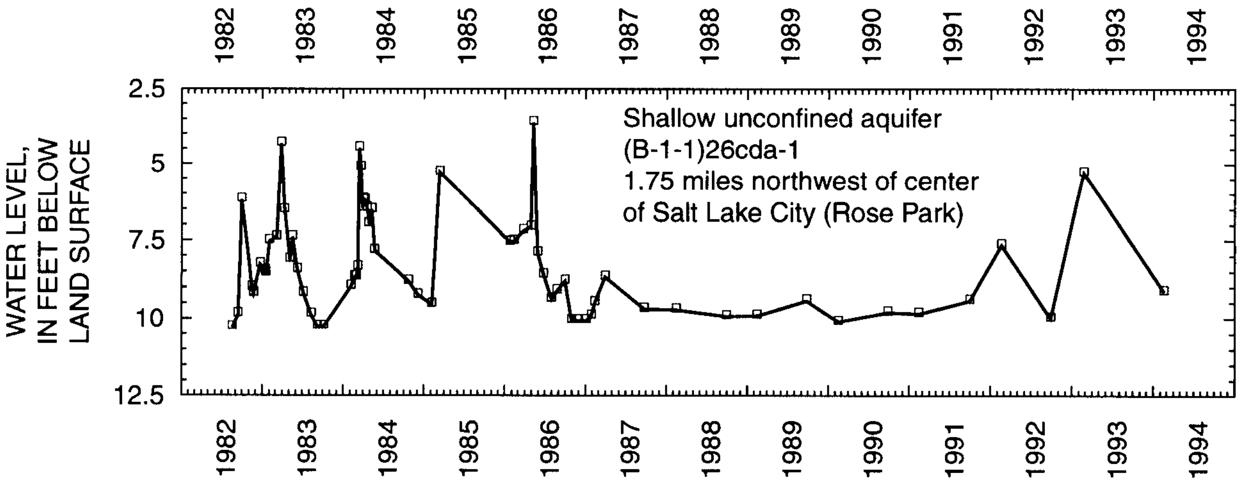


Figure 10. Relation of water levels in selected wells in the principal aquifer in Salt Lake Valley to cumulative departure from the average annual precipitation at Silver Lake Brighton, and relation of water levels in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.



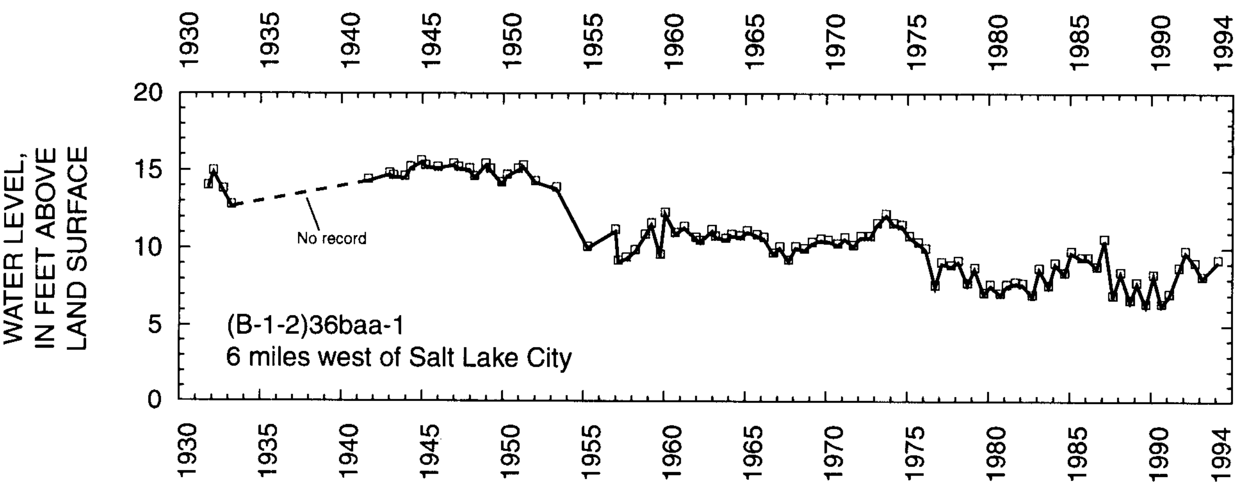


Figure 11. Water levels in selected wells in the shallow unconfined aquifer and the principle aquifer in Salt Lake Valley.

TOOELE VALLEY

by M.R. Danner

Withdrawals from wells in Tooele Valley in 1993 were about 22,000 acre-feet. This is 8,000 acre-feet less that was reported for 1992 and 4,000 less than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for 1989-93, 28,000 acre-feet, was 5,000 acre-feet more than for the preceding five-year period, 1984-88.

Water levels declined throughout most of Tooele Valley from March 1989 to March 1994, with the largest declines occurring in the southeastern part of the valley near Tooele. The maximum decline of nearly 40 feet was measured in a well about 2 miles north of Tooele (fig. 12). These declines probably are the result of increased withdrawals, primarily for irrigation and public supply, and decreased recharge for 1989-93 as compared with the previous five-year period, 1984-88. Recharge decreased because of less precipitation during 1988-93 than during 1983-88. Minor water level rises occurred in areas north of Grantsville and northwest of Erda from March 1989 to March 1994.

The relation of water levels in selected wells in Tooele Valley to cumulative departure from the average annual precipitation at Tooele, to annual withdrawals from wells, and to concentrations of dissolved solids in water from well (C-2-6)23cbb-1 is shown in figure 13. Precipitation during 1993 at Tooele was 20.73 inches, 7.89 inches more than in 1992 and 3.34 inches more than the average annual precipitation for the period 1989-93. Average annual precipitation at Tooele for 1989-93, 17.39 inches, was 4.40 inches less than the average for the previous five years, 1984-88. The concentration of dissolved solids in water from well (C-2-6)23cbb-1 has generally declined since 1960, and especially since 1982, although no data are available since 1991.

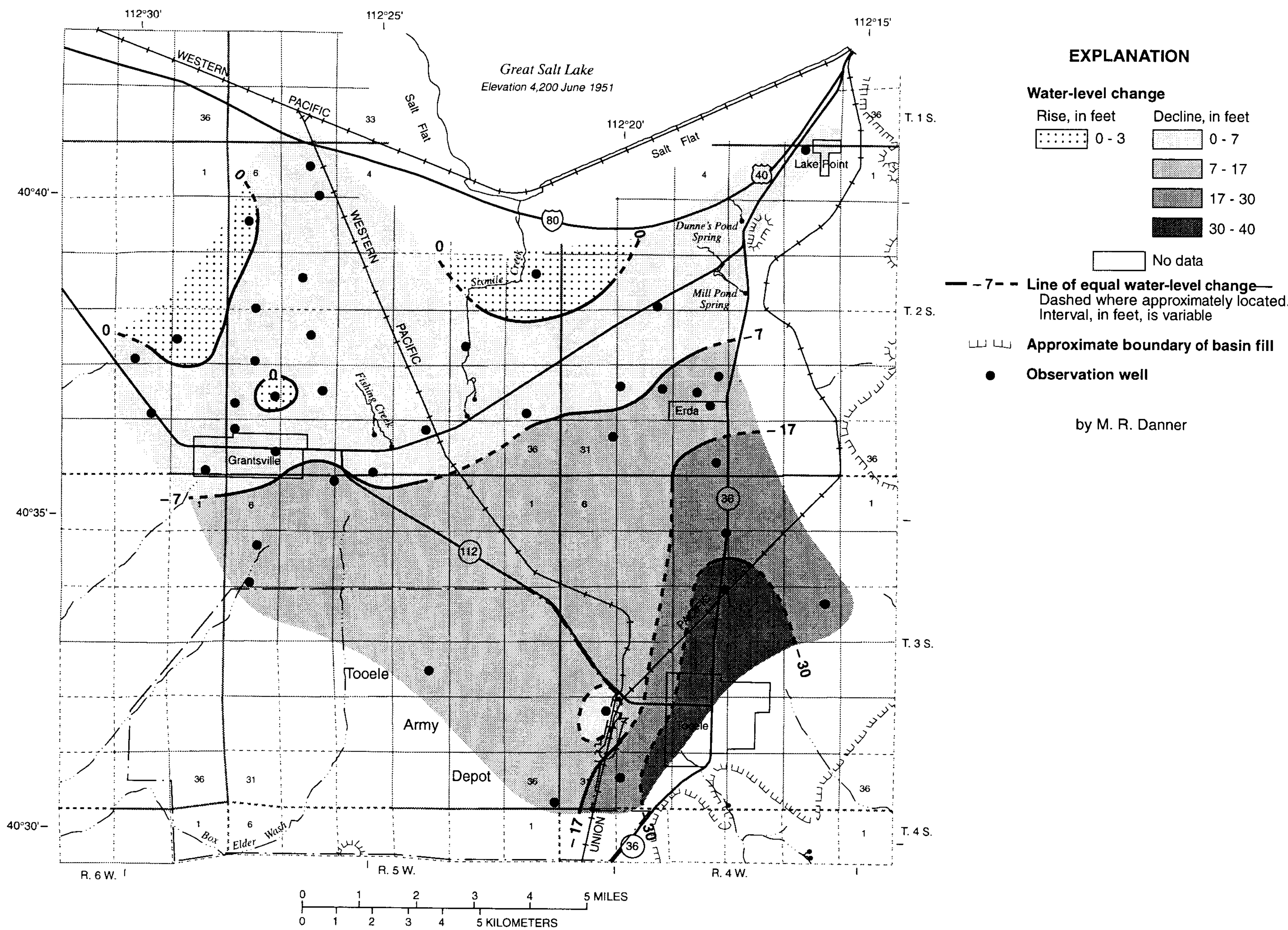


Figure 12. Map of Tooele Valley showing change of water levels from March 1989 to March 1994.

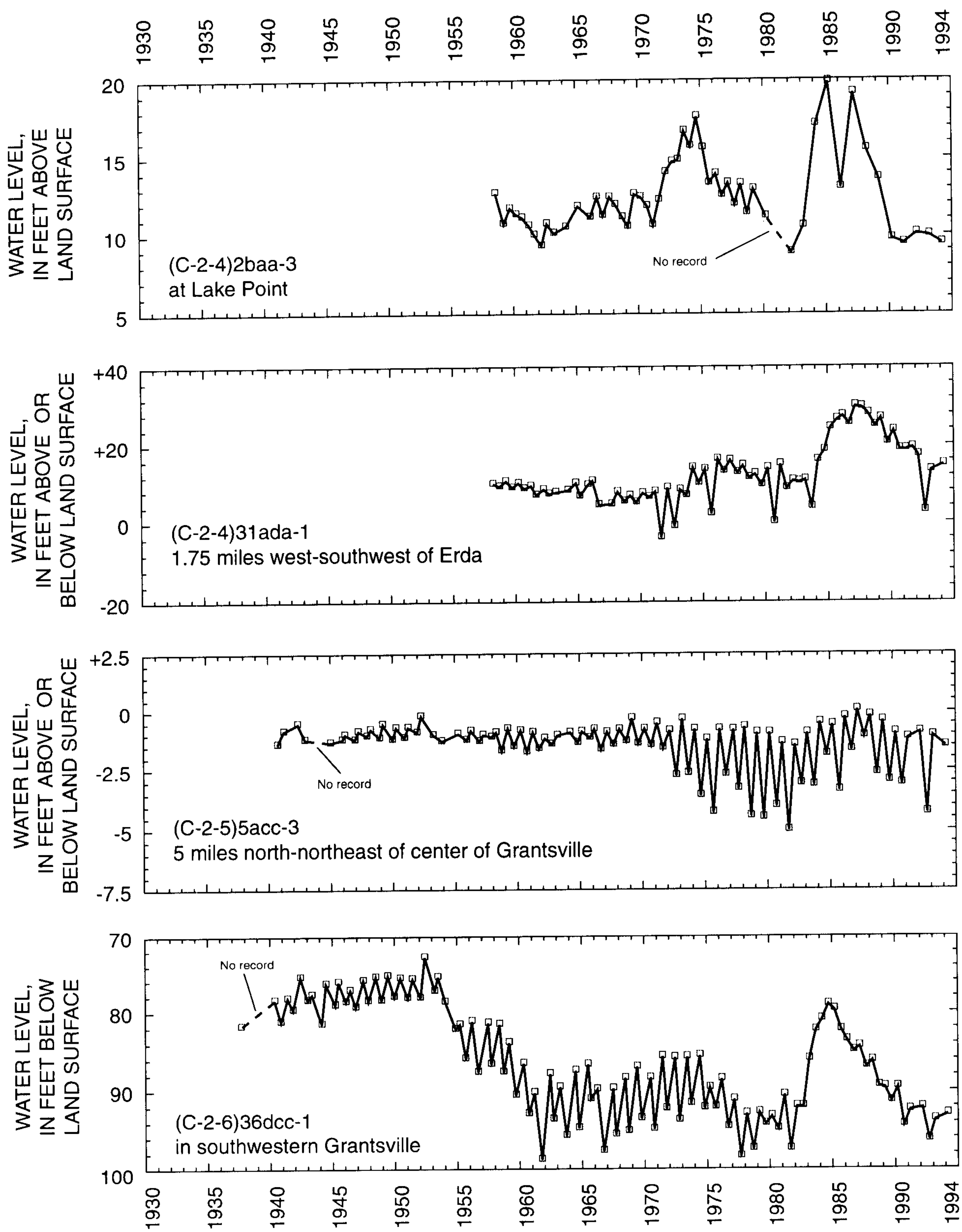


Figure 13. Relation of water levels in selected wells in Tooele Valley to cumulative departure from the average annual precipitation at Tooele, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-2-6)23cbb-1.

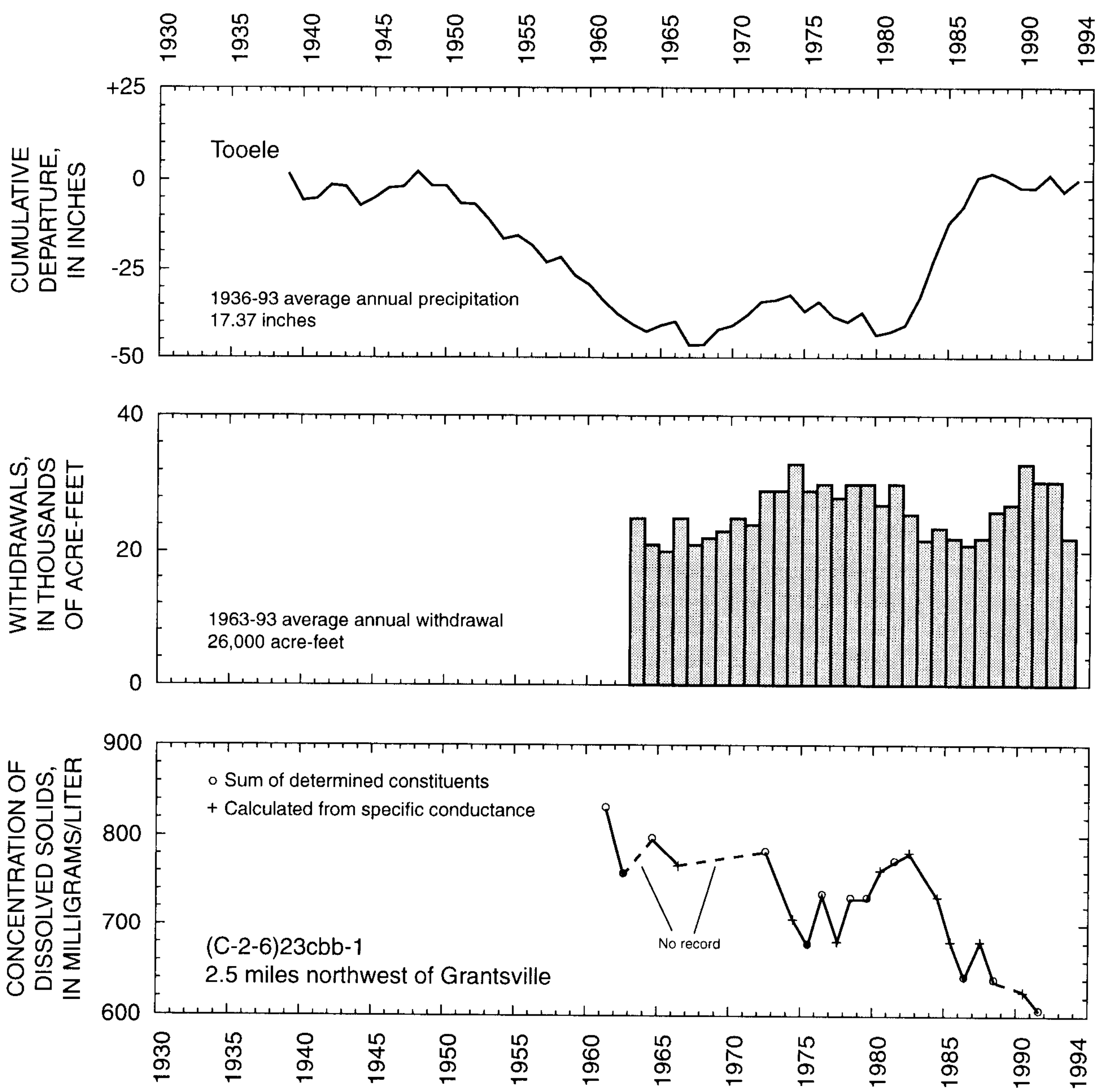


Figure 13. Relation of water levels in selected wells in Tooele Valley to cumulative departure from the average annual precipitation at Tooele, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-2-6)23cbb-1—Continued.

UTAH AND GOSHEN VALLEYS

by L.R. Herbert

Withdrawal of water from wells in Utah and Goshen Valleys in 1993 was about 89,000 acre-feet. This was 52,000 acre-feet less than the withdrawal in 1992, and 16,000 acre-feet less than the average annual withdrawal for 1983-92 (tables 2 and 3). The 1989-93 average annual withdrawal of 121,000 acre-feet was 29,000 acre-feet more than for the preceding five-year period of 1984-88. Withdrawal in Utah Valley was about 76,200 acre-feet, 50,400 acre-feet less than in 1992. This was mainly because of decreased withdrawals for public supply and irrigation uses. Withdrawal in Goshen Valley was about 12,700 acre-feet, 1,700 acre-feet less than in 1992.

Water levels generally rose in the northern part of Utah Valley from March 1989 to March 1994, and declined in the southern part of Utah valley and Goshen Valley (fig. 14). The rises in northern Utah Valley may be the result of significantly decreased withdrawals and increased recharge from precipitation in the area during 1993, as compared with the average withdrawal and precipitation for the five-year period, 1989-93. The declines in the southern part of Utah Valley and most of Goshen Valley were because of continued large withdrawals and decreased recharge from less precipitation and surface water during 1989-93 than for the previous five year period, 1984-88. The largest declines, about 8 feet, were observed southeast of Spanish Fork and near Elberta (fig. 14), and the largest rise, 23.5 feet, occurred near Alpine.

The relation of water levels in selected wells to cumulative departure from the average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to annual withdrawals for public supply, to total annual withdrawals from wells, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from selected wells is shown in figure 15.

The 1989-93 average discharge at Spanish Fork River at Castilla was 89,860 acre-feet, 28,910 acre-feet less than the average for 1984-88. The average annual precipitation at Timpanogos during 1989-93 was 23.72 inches, 1.39 inches less than the average during 1984-88. Average annual precipitation for 1989-93 at Spanish Fork Powerhouse was 18.42 inches, 3.96 inches less than the average during 1984-88.

The water level in observation well (D-9-2)11aaa-1 rose about 35 feet during 1982-84 and declined about 48 feet during 1985-1993. The rise approximately corresponded to greater-than-average precipitation during 1981-86 and lower quantity of ground-water withdrawals during 1982-86. The decline in water level since 1984 approximately corresponded to less-than-average precipitation during 1987-92 than the six previous years, and to increased withdrawals during 1987-92 as compared with the five previous years.

Dissolved-solids concentration in water from well (C-10-1)4cbb-1 increased during 1977-86, and may have decreased since 1986; dissolved-solids concentration in water from well (D-7-3)34cdb-1 have decreased since 1987. Dissolved-solids concentration in water from well (D-5-1)19ccc-1 has increased from a low of 114 milligrams per liter in 1991 to a maximum of almost 255 milligrams per liter in 1993.

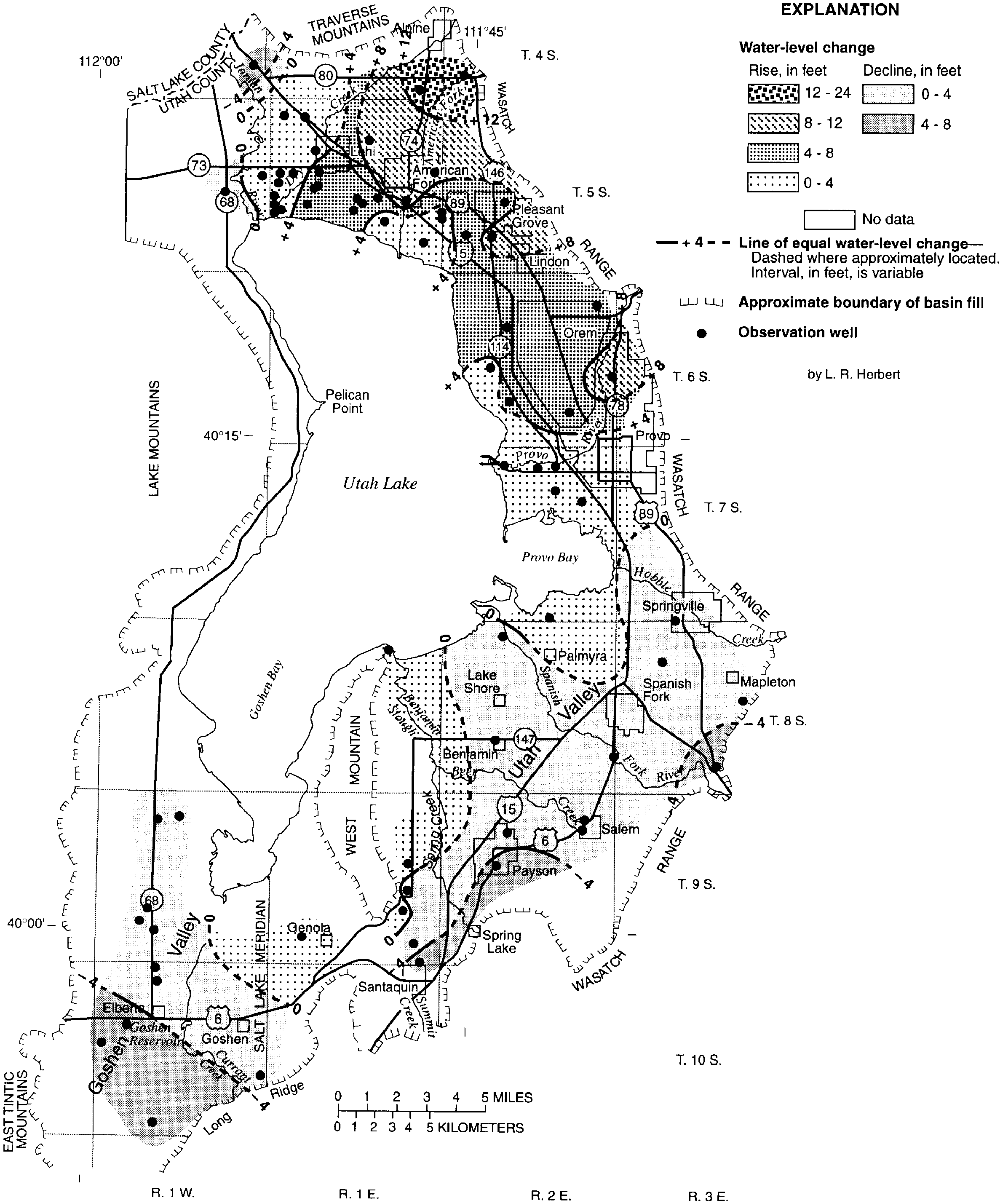


Figure 14. Map of Utah and Goshen Valleys showing change of water levels from March 1989 to March 1994.

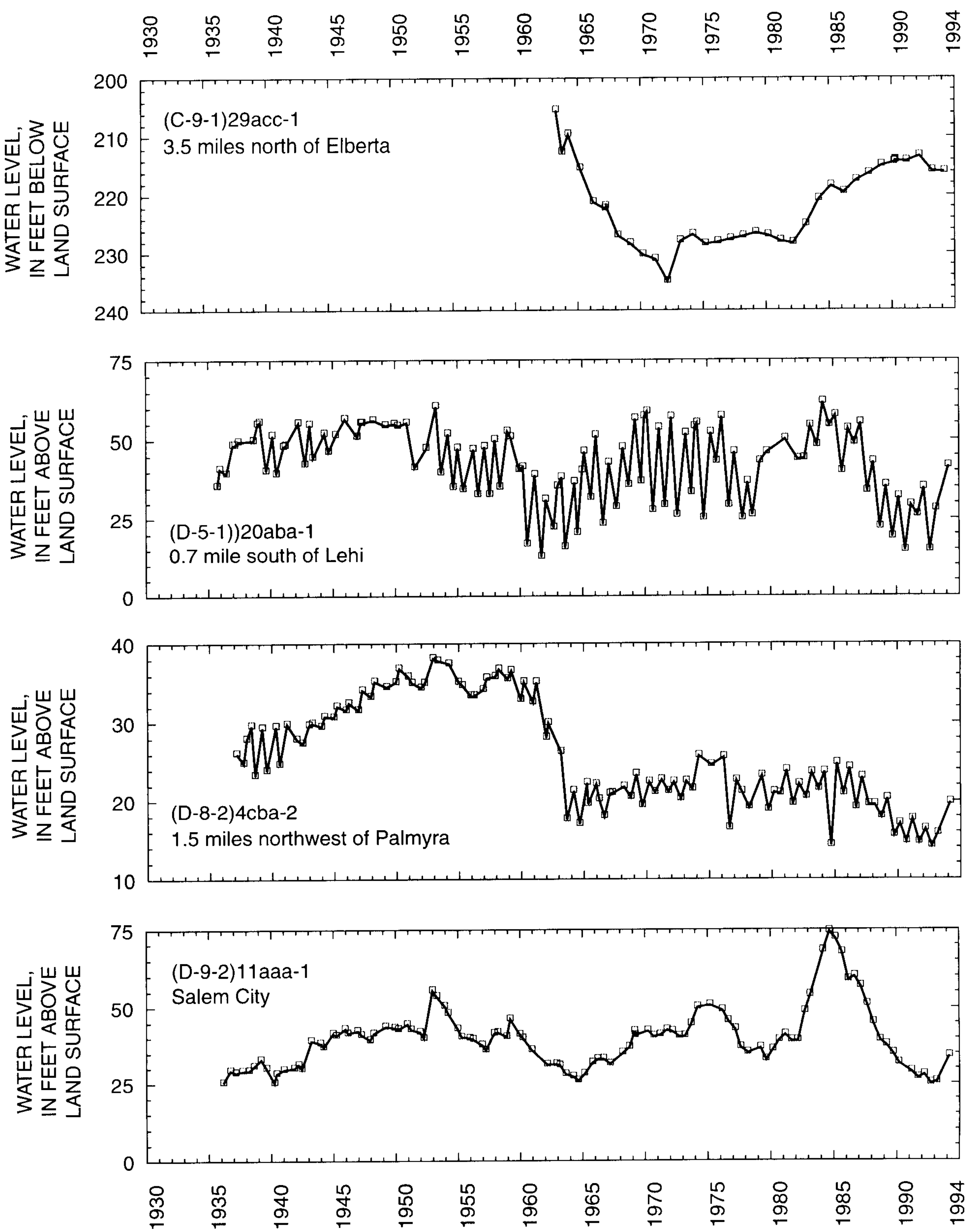


Figure 15. Relation of water levels in selected wells in Utah and Goshen Valleys to cumulative departure from the average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to annual withdrawals for public supply, to total annual withdrawals from wells, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from selected wells.

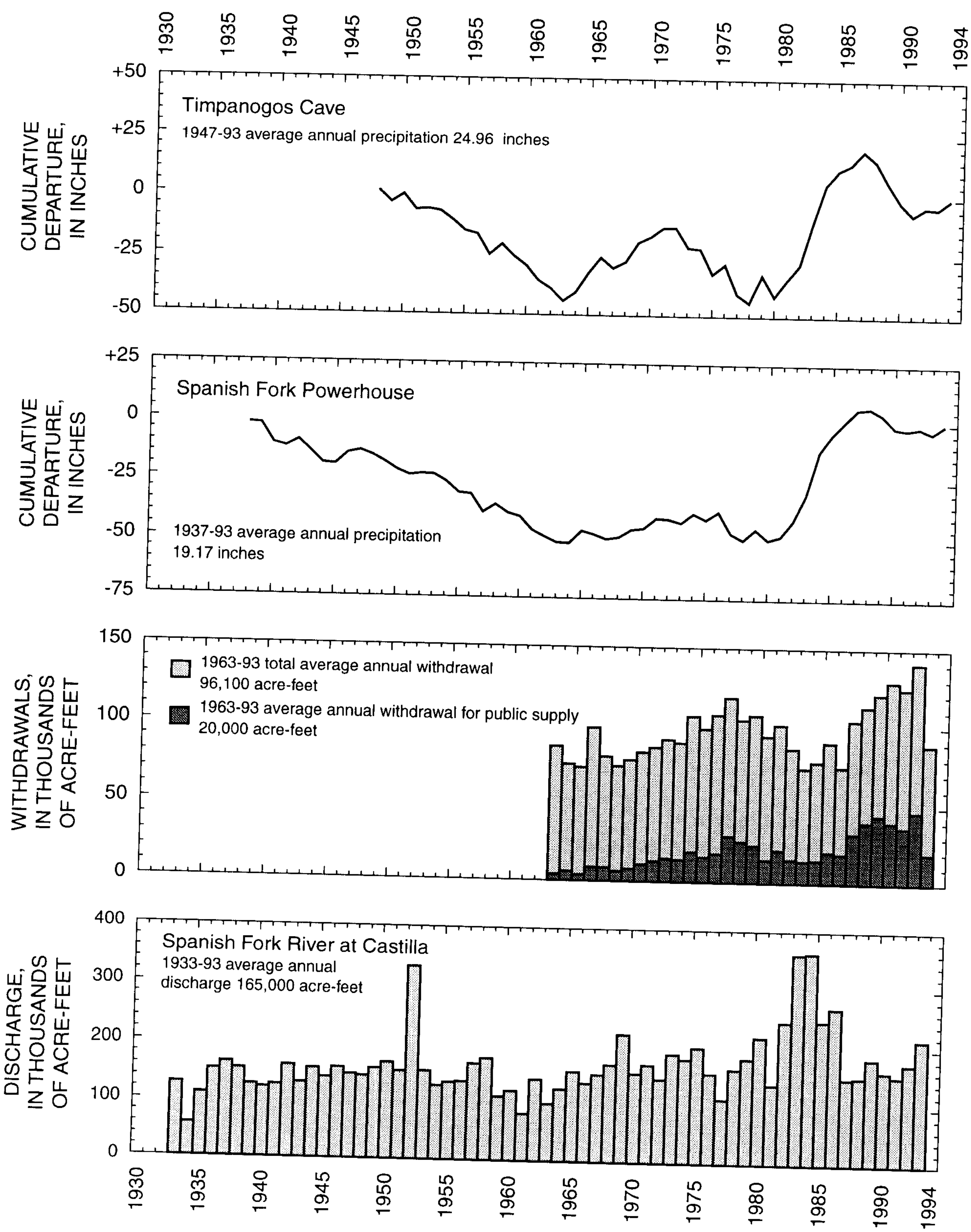


Figure 15. Relation of water levels in selected wells in Utah and Goshen Valleys to cumulative departure from the average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to annual withdrawals for public supply, to total annual withdrawals from wells, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.

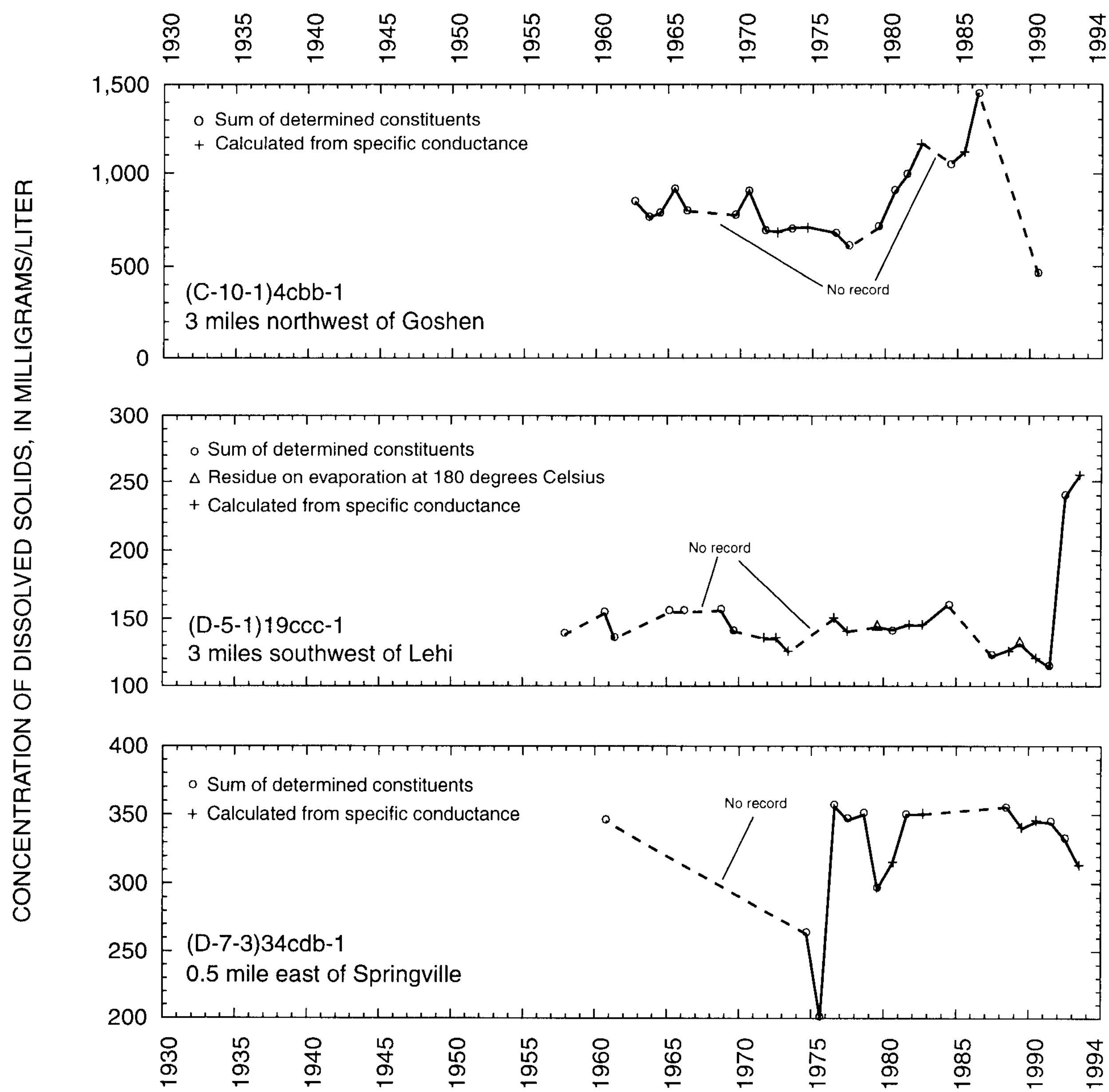


Figure 15. Relation of water levels in selected wells in Utah and Goshen Valleys to cumulative departure from the average annual precipitation at Timpanogos Cave and Spanish Fork Powerhouse, to annual withdrawals for public supply, to total annual withdrawals from wells, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from selected wells—Continued.

JUAB VALLEY

by J.I. Steiger

Withdrawal of water from pumped and flowing wells in Juab Valley in 1993 was about 20,000 acre-feet. This is 9,000 acre-feet less than was reported for 1992 and 1,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for 1989-93, 26,000 acre-feet, was 12,000 acre-feet more than for the preceding five-year period, 1984-88, mainly because of greater withdrawals for irrigation. The increased withdrawals for irrigation are the results of less available surface water because of less precipitation during 1989-93 than during 1984-88.

Water levels declined throughout Juab Valley from March 1989 to March 1994. Declines of as much as 9.3 feet were recorded in the irrigated areas north of Mona, and the largest decline, 27.9 feet, was measured in Levan (fig. 16). The declines are related to increased withdrawals for irrigation and less recharge from less-than-average precipitation and streamflow during 1989-93 as compared with the preceding five-year period, 1984-1988. Local water level rises of less than 1 foot occurred in wells northwest of Mona and about 4 miles northwest of Levan.

The relation of water levels in selected wells to cumulative departure from the average annual precipitation at Nephi, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1 is shown in figure 17. Precipitation at Nephi during 1993 was 17.30 inches, which is 3.00 inches more than the average annual precipitation for 1935-93. The 1989-93 average annual precipitation was 14.13 inches, which is 1.39 inches less than the average for the preceding five-year period, 1984-88. The concentration of dissolved solids in water from well (D-13-1)7dbc-1 fluctuated from 1964-93 with no apparent trend. The concentration of dissolved solids for 1993 was about the same as in 1991.

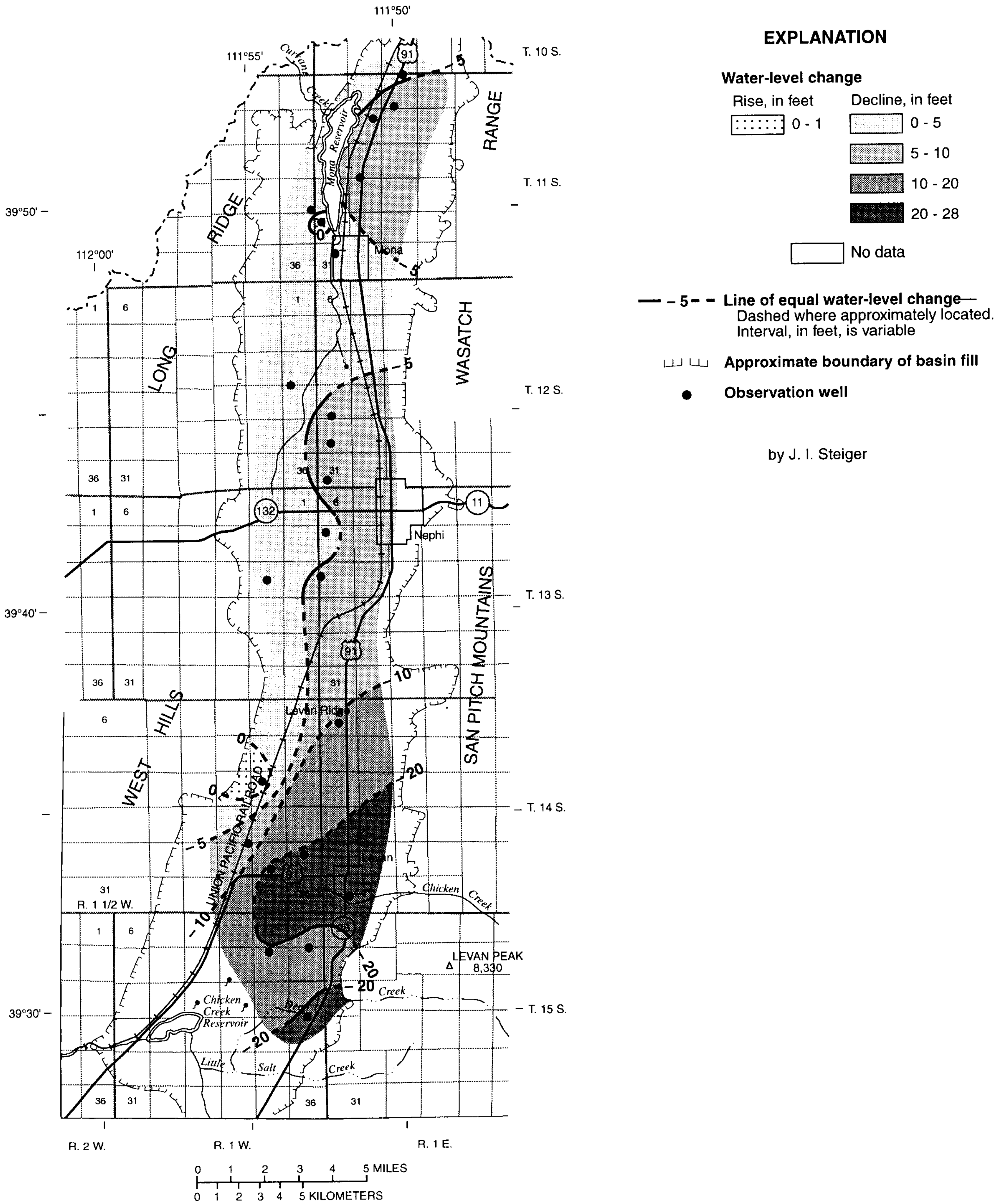


Figure 16. Map of Juab Valley showing change of water levels from March 1989 to March 1994.

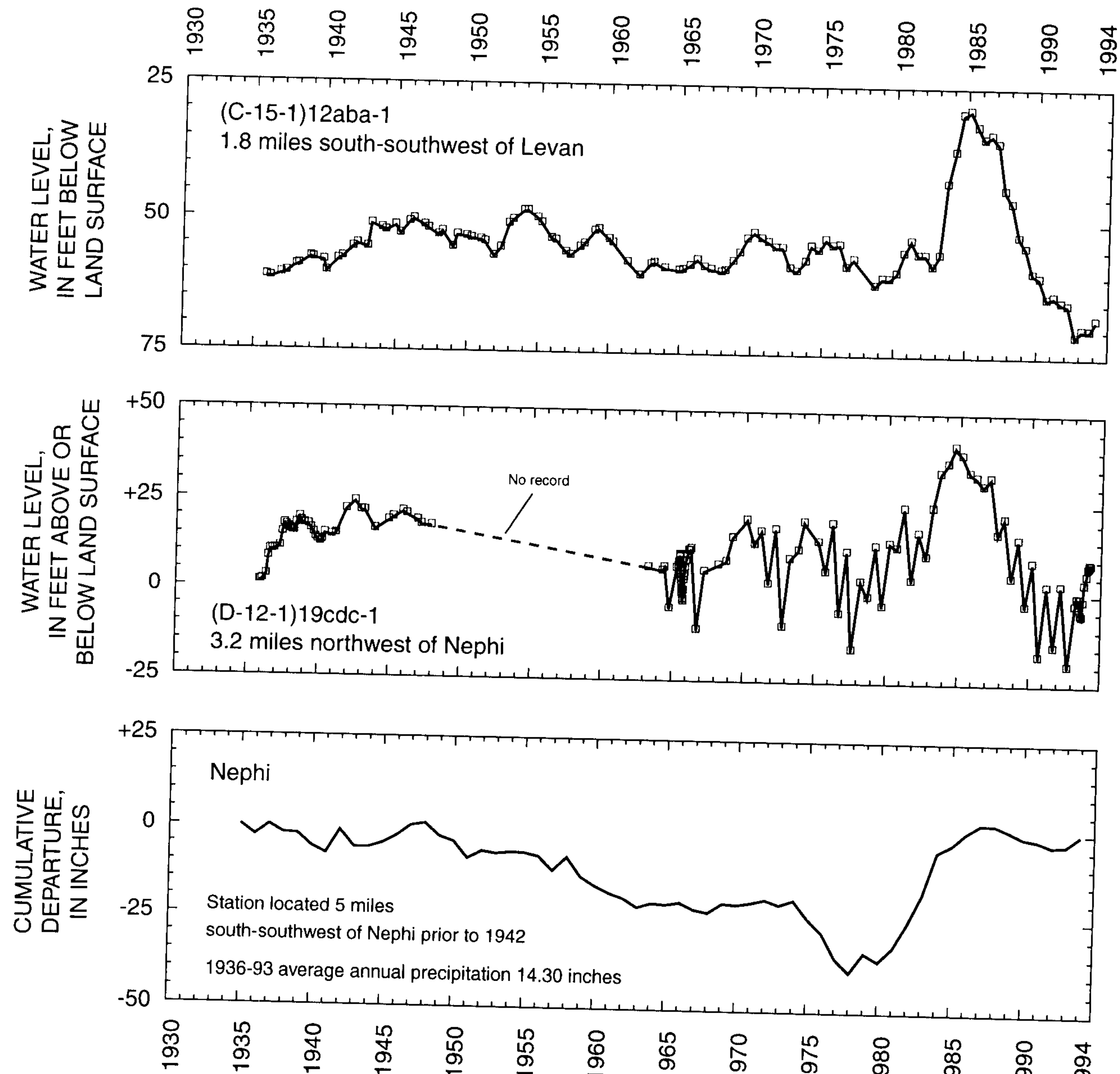


Figure 17. Relation of water levels in selected wells in Juab Valley to cumulative departure from the average annual precipitation at Nephi, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (B-13-1)7dbc-1.

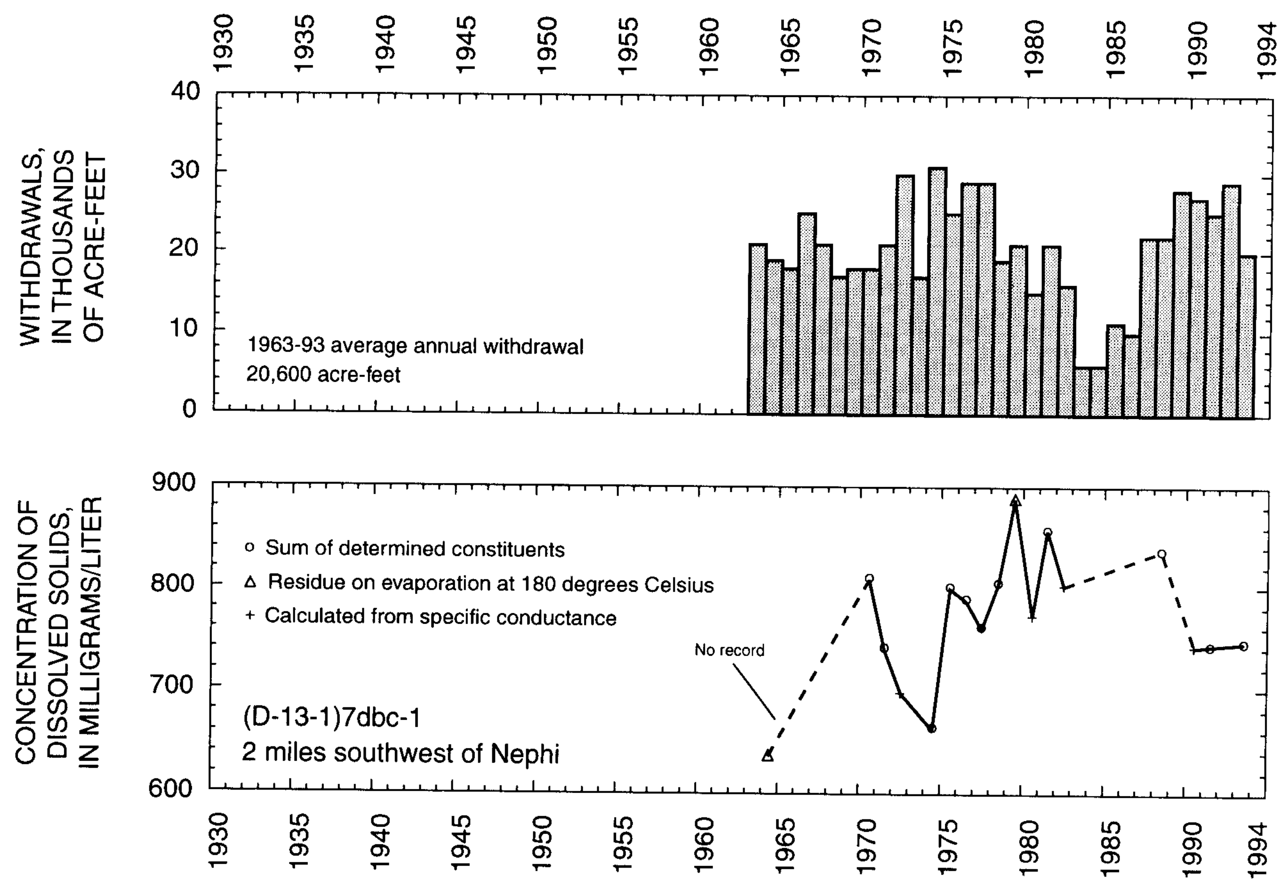


Figure 17. Relation of water levels in selected wells in Juab Valley to cumulative departure from the average annual precipitation at Nephi, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.

SEVIER DESERT

by M.D. ReMillard

Withdrawal of water from wells in the Sevier Desert in 1993 was about 31,000 acre-feet. This is 2,000 acre-feet less than was reported for 1992 and about 12,000 acre-feet more than the 1983-92 average annual withdrawal (tables 2 and 3). The average annual withdrawal during 1989-93 was 29,800 acre-feet, about 17,000 acre-feet more than the average for the preceding five-year period, 1984-88.

Water levels in the shallow artesian aquifer generally declined from March 1989 to March 1994 (fig. 18). The largest declines were found in an area south of Leamington and from Oak City west to the Sevier River. Water levels rose slightly in a small area near the Little Drum Mountains. Water levels in the deep artesian aquifer generally declined from March 1989 to March 1994 (fig. 19). The largest decline, about 27 feet was observed near Oak City. The declines generally were smaller toward the west and southwest. Declines in water levels in both aquifers probably are because of increased withdrawals during 1989-93, as compared with the preceding five-year period, and to less recharge resulting from less-than-average precipitation and less streamflow during 1989-93, as compared with the preceding five-year period.

The relation of water levels in selected wells to discharge of the Sevier River near Juab, to cumulative departure from the average annual precipitation at Oak City, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1 is shown in figure 20.

Discharge of the Sevier River during 1993 was 127,200 acre-feet, 5,900 acre-feet more than 1992 and 55,200 acre-feet less than the long term average (1935-93). Average annual flow of the Sevier River during 1989-93 was 123,000 acre-feet, about 346,000 acre-feet less than for the preceding five-year period, 1984-88.

Precipitation at Oak City was 12.83 inches in 1993, 0.14 inch more than the 1935-93 average annual precipitation. Average annual precipitation for 1989-93 was 10.62 inches, 4.13 inches less than for the preceding five-year period, 1984-88.

The concentration of dissolved solids in water from well (C-15-4)18daa-1, near Lynndyl, has increased from about 900 milligrams per liter in 1958 to about 1900 milligrams per liter in 1993. This increase may be a result of recharge from irrigation using water which contains more dissolved solids than local ground water (Handy and others, 1969).

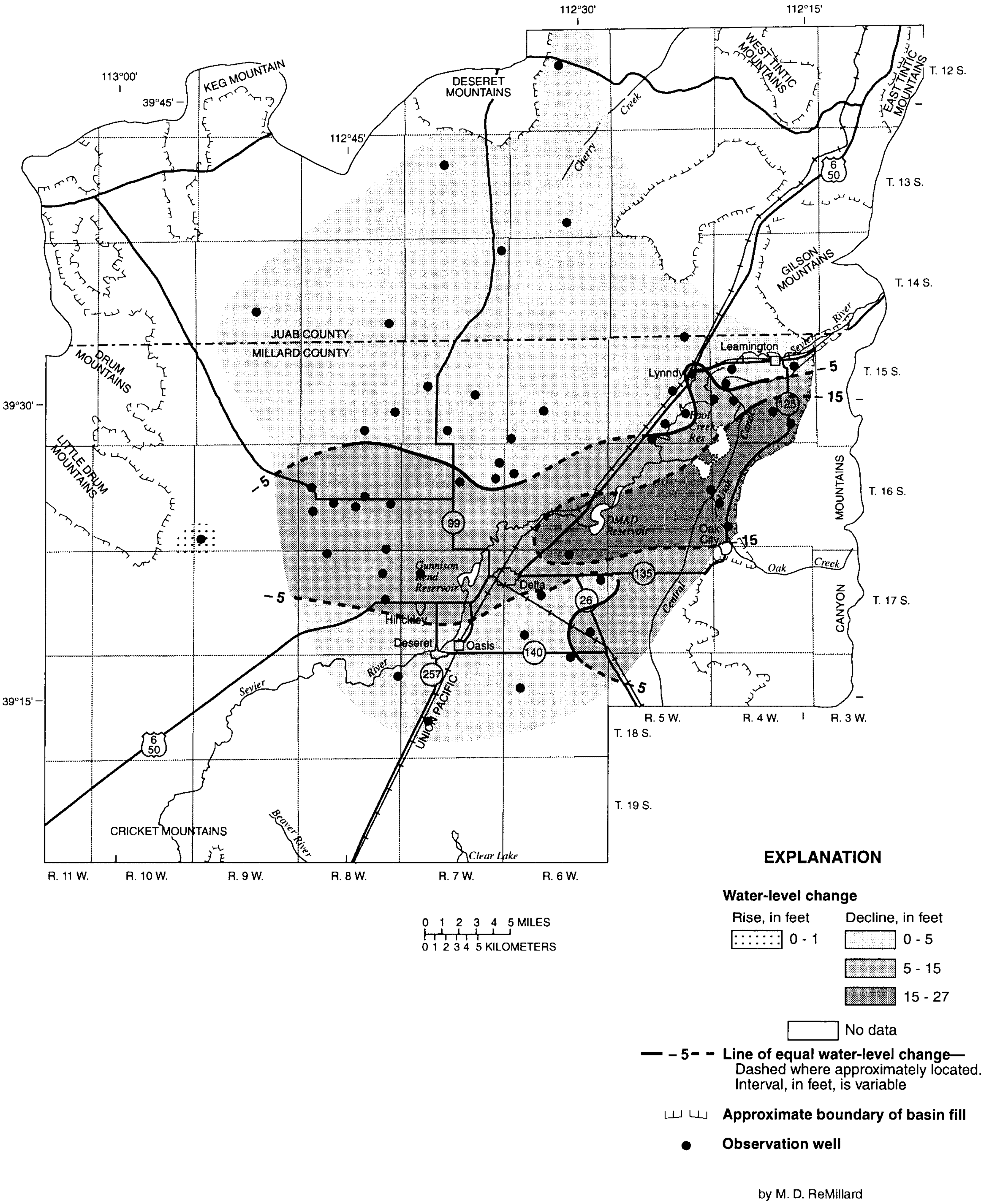


Figure 18. Map of part of the Sevier Desert showing change of water levels in the shallow artesian aquifer from March 1989 to March 1994.

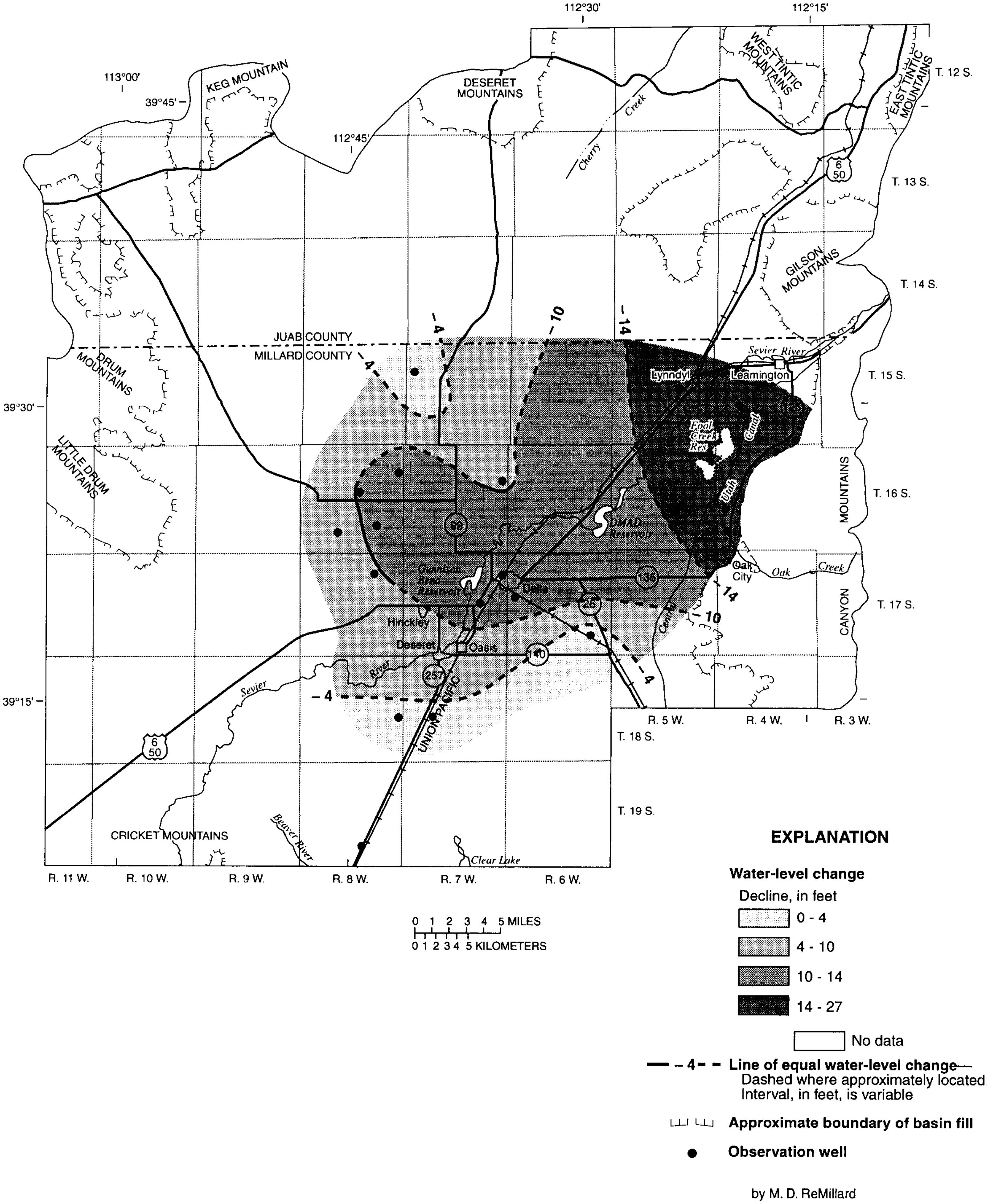


Figure 19. Map of part of the Sevier Desert showing change of water levels in the deep artesian aquifer from March 1989 to March 1994.

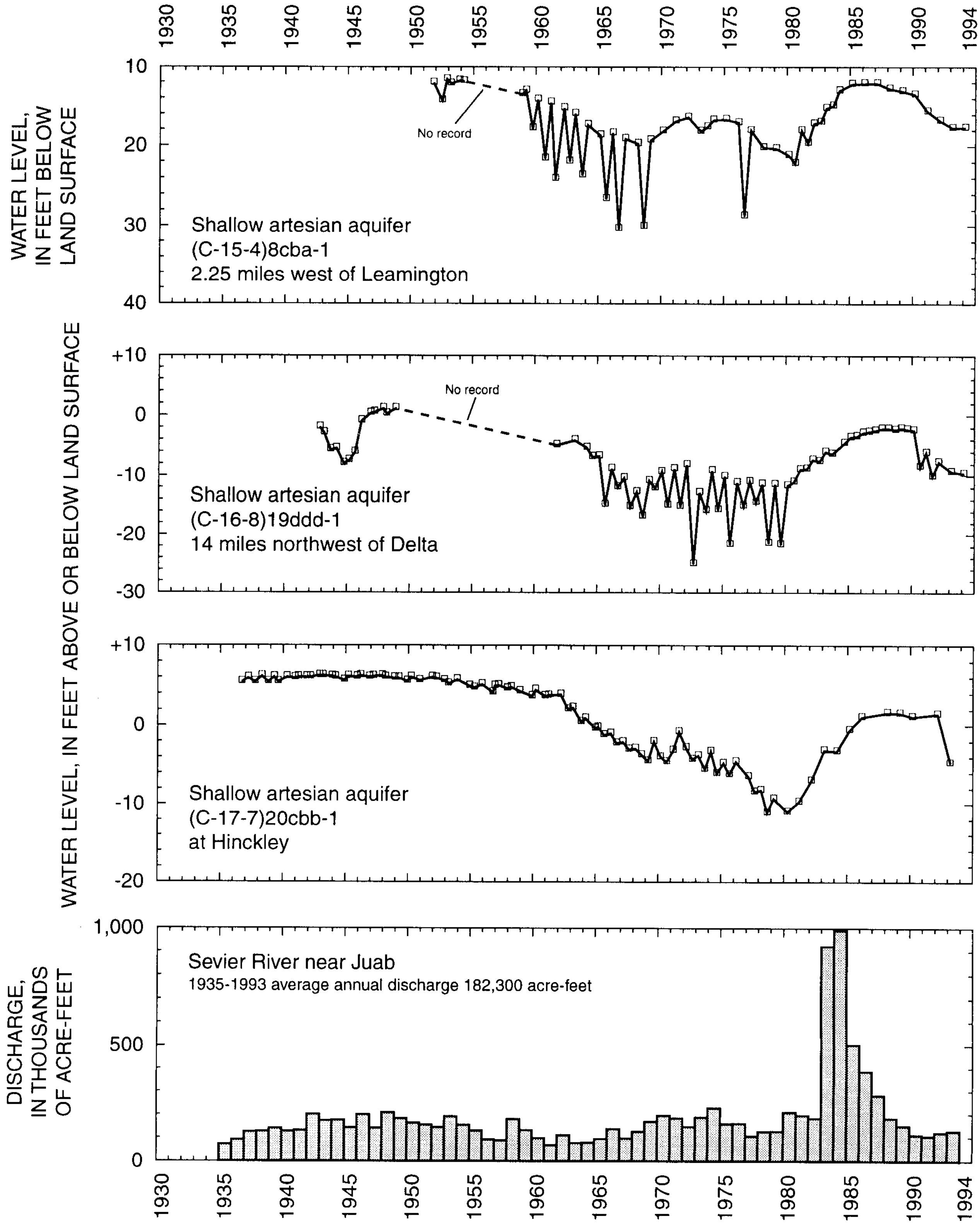


Figure 20. Relation of water levels in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from the average annual precipitation at Oak City, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1.

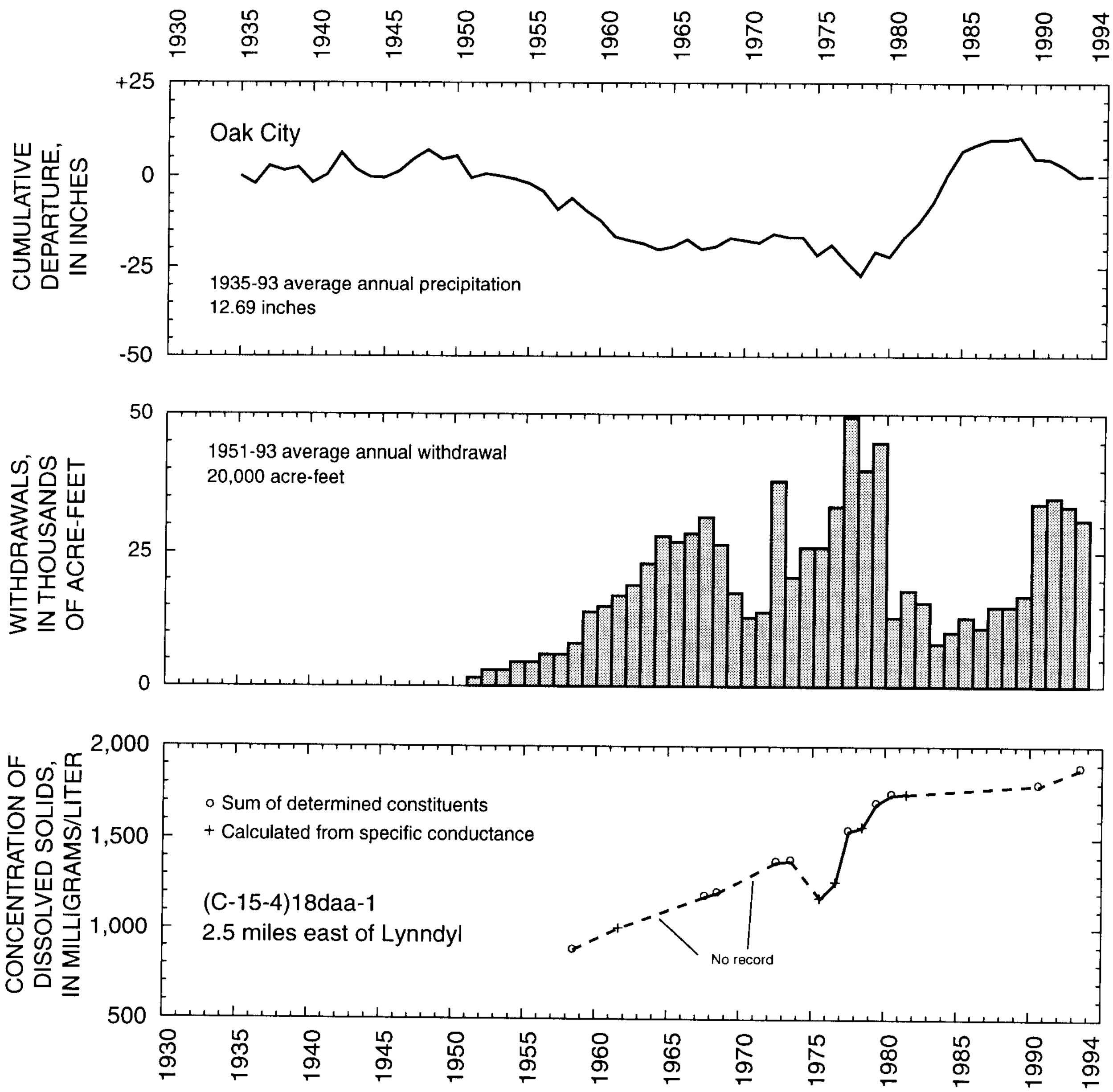


Figure 20. Relation of water levels in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from the average annual precipitation at Oak City, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

CENTRAL SEVIER VALLEY

by B.A. Slaugh

Withdrawal of water from wells in the central Sevier Valley in 1993 was about 19,000 acre-feet; the same as in 1992. The 1993 withdrawal is also 1,000 acre-feet more than the ten-year average for 1983-92 and five-year average for 1989-93, but is 2,000 acre-feet more than the five-year average for 1984-88 (tables 2 and 3).

Water levels declined in most of the central Sevier Valley from March 1989 to March 1994 (fig. 21). The largest decline, 8.0 feet, was measured in a well about 2 miles west of Central. The decline in water levels probably is because of less precipitation, resulting in less streamflow and less recharge during 1989-93 than during 1984-88, and possibly because of slightly greater withdrawals during 1989-93 than during 1984-88. Water levels rose slightly, less than 1 foot, east of Venice and south of Richfield.

The relation of water levels in selected wells to discharge of the Sevier River at Hatch, to cumulative departure from the average annual precipitation at Salina, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4 is shown in figure 22. Discharge of the Sevier River at Hatch in 1993 was about 149,000 acre-feet, about 94,600 acre-feet more than the 54,400 acre-feet for 1992 and about 69,800 acre-feet more than the 1940-93 average annual discharge. The average annual discharge during 1989-93 was about 64,500 acre-feet, approximately 20,400 acre-feet less than the 1984-88 average annual discharge.

Precipitation at Salina was 11.49 inches in 1993, which was 1.52 inches more than the 1935-93 average annual precipitation. The average annual precipitation for 1989-93 was 8.93 inches, 0.78 inch less than the average for the preceding five-year period, 1984-88. The concentration of dissolved solids in water from well (C-23-2)15dcb-4 has ranged from about 330 milligrams per liter to about 600 milligrams per liter with no apparent long-term trend.

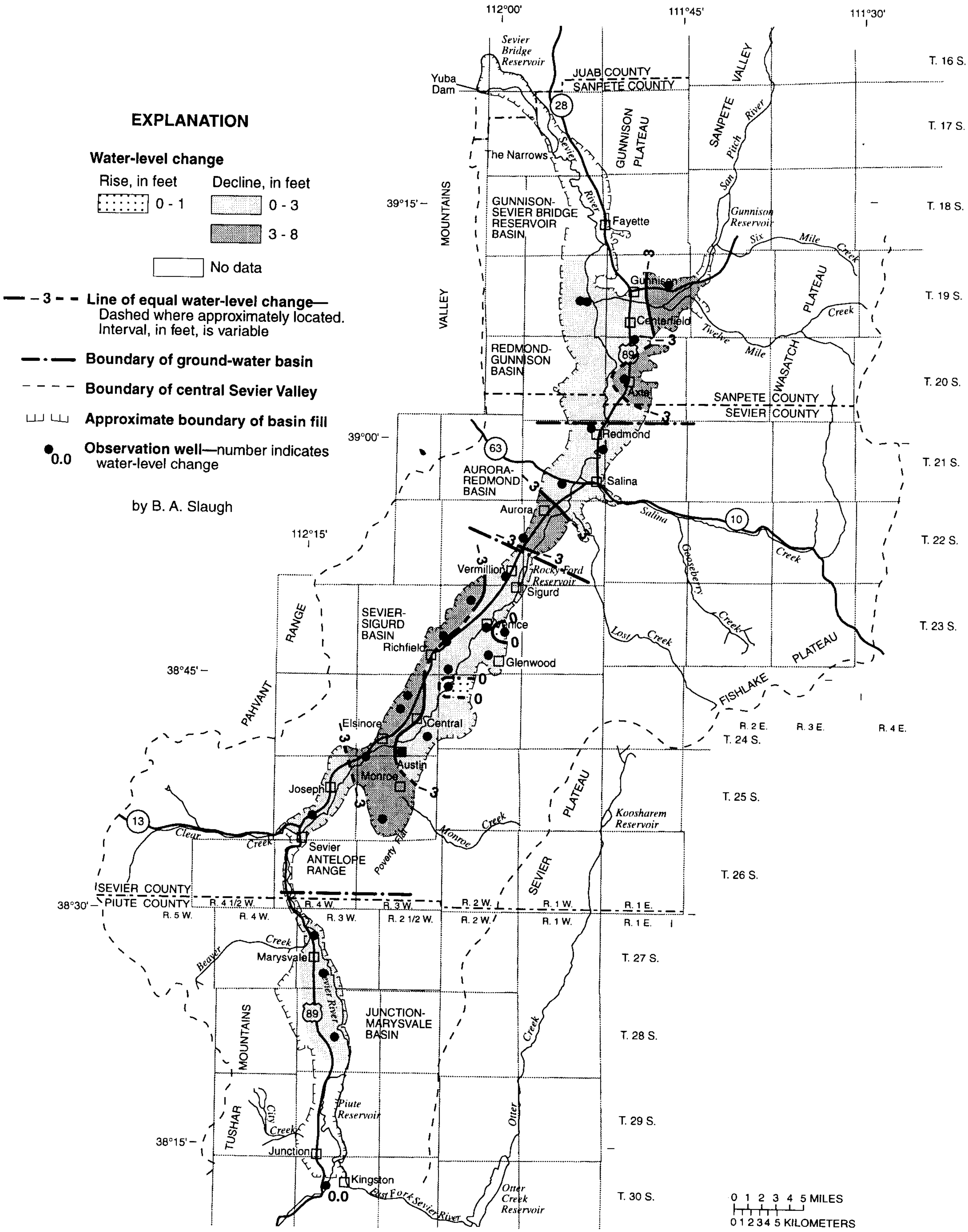


Figure 21. Map of the central Sevier Valley showing change of water levels from March 1989 to March 1994.

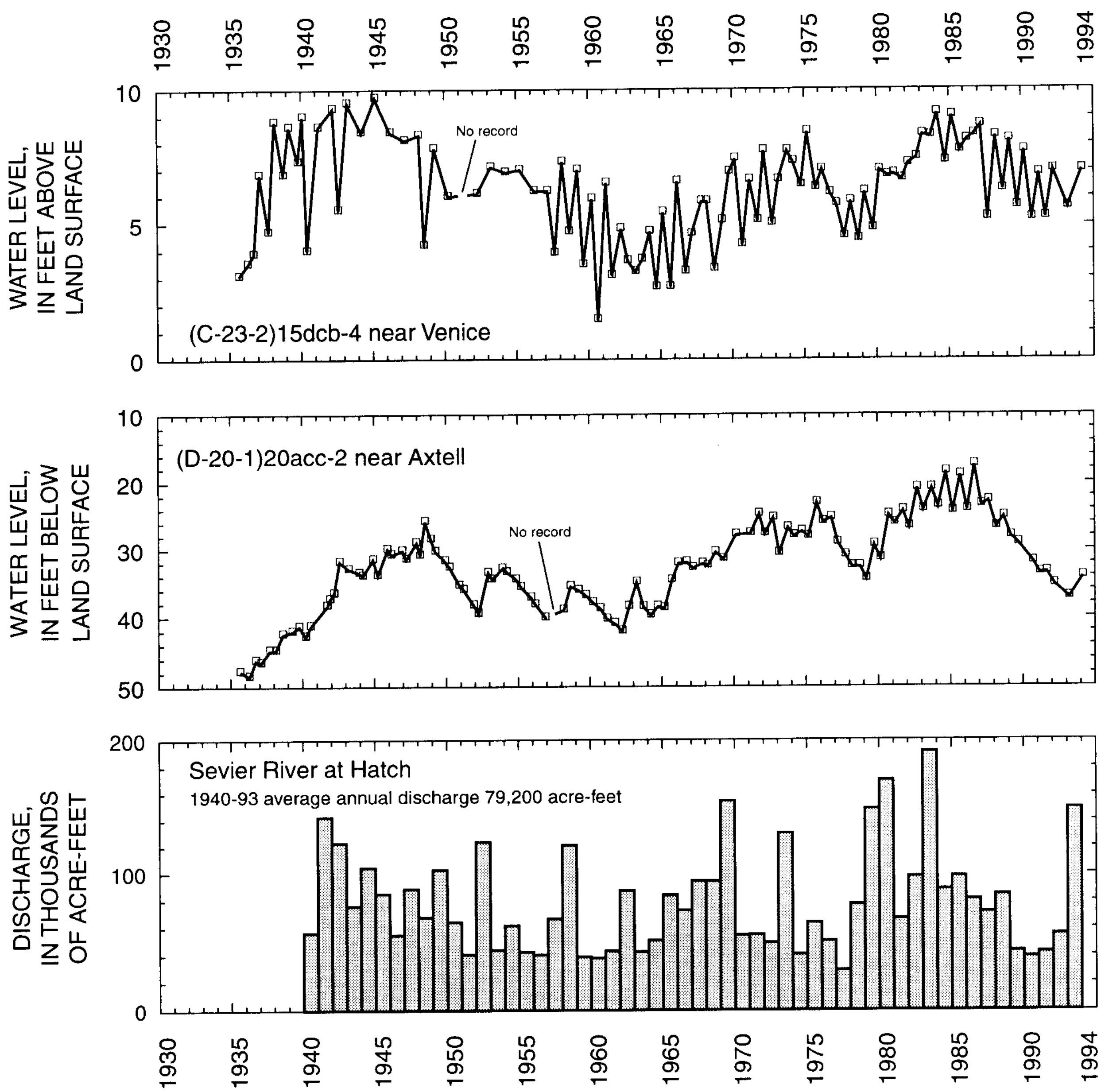


Figure 22. Relation of water levels in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from the average annual precipitation at Salina, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4.

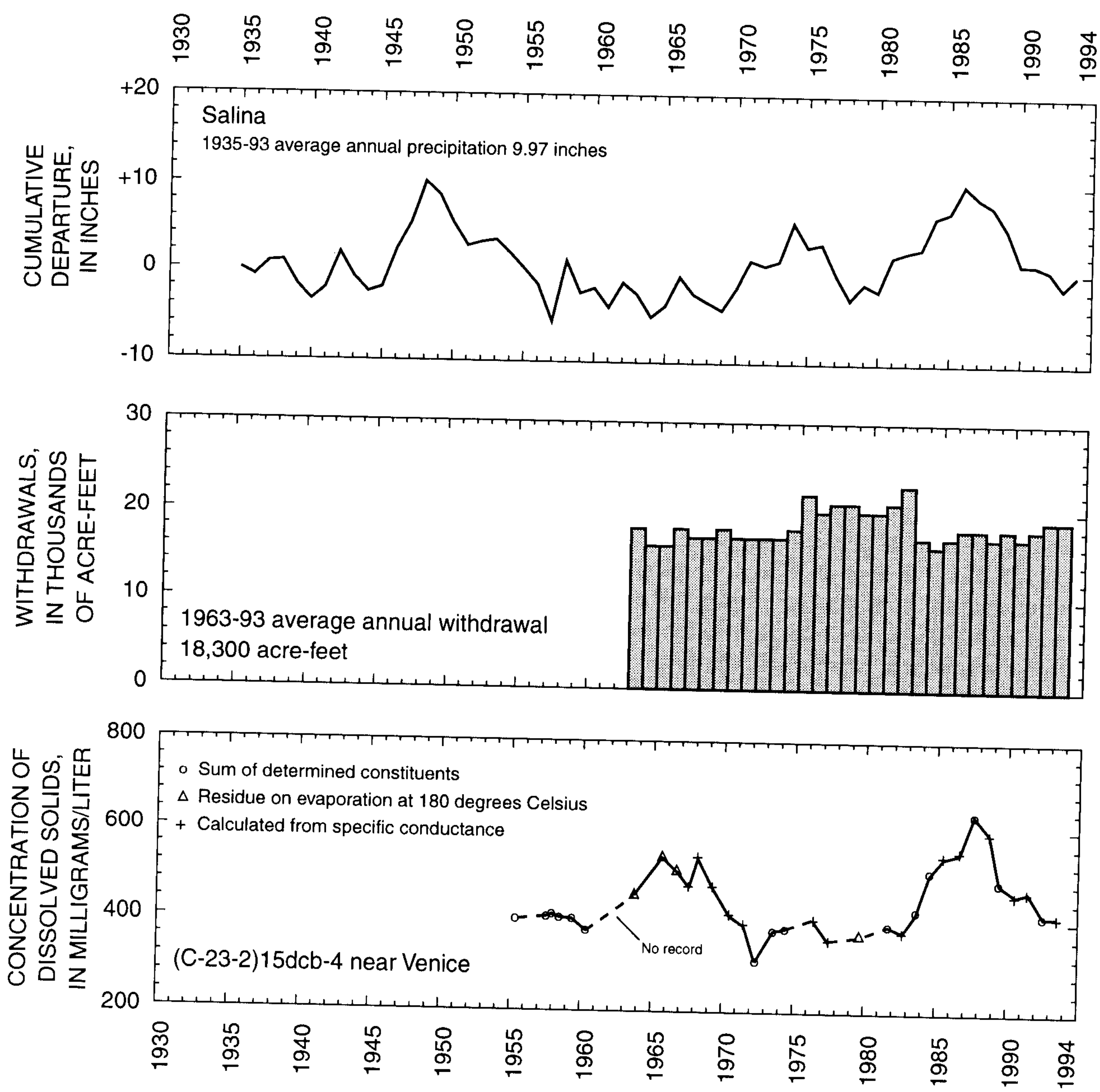


Figure 22. Relation of water levels in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from the average annual precipitation at Salina, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.

PAHVANT VALLEY

by R.L. Swenson

Withdrawal of water from wells in Pahvant Valley in 1993 was about 87,000 acre-feet. This was 1,000 acre-feet more than reported in 1992, and 20,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). Irrigation withdrawal for 1993 was 86,400 acre-feet, 1,000 acre-feet greater than the withdrawal reported in 1992. Withdrawals generally have increased during the last ten years from an annual average of 60,000 acre-feet during 1984-88, to an annual average of 83,000 acre-feet during 1989-93.

Water levels declined in most of Pahvant Valley from March 1989 to March 1994 (fig. 23). The maximum decline of almost 48 feet occurred just west of Holden. Declines of 25 feet or greater also occurred in areas along the eastern part of the valley just west of Fillmore, south of Meadow to Kanosh, and in a small area in the southernmost part of the valley. Declines in water levels probably resulted from slightly increased withdrawals for irrigation and less precipitation during 1989-93 as compared with 1984-88. Water level rises of less than one foot occurred in local areas along the extreme western edge of the Valley west of Fillmore and about 6 miles northwest of Holden.

The relation of water levels in selected wells to cumulative departure from the average annual precipitation at Fillmore and to annual withdrawals from wells is shown in figure 24. Precipitation at Fillmore during 1993 was 15.96 inches, which is 1.04 inches more than the average annual precipitation for 1931-93 (fig. 24). The average annual precipitation during 1989-93, 13.76 inches, was 3.54 inches less than the average for the preceding five-year period, 1984-88.

The concentration of dissolved solids in water from wells near Flowell and west of Kanosh are shown in figure 25. The sample from well (C-21-5)7cdd-3, northwest of Flowell, showed a slight decrease in dissolved solids in 1993. The sample from well (C-23-6)21bdd-1, west of Kanosh, showed a slight increase in concentration of dissolved solids since the last sample taken in 1990. Water from both wells shows a general increase in concentration since the mid 1950's, although the lower concentrations in water from both wells since the late 1970's may be related to increased recharge associated with greater-than-average precipitation during 1980-86.

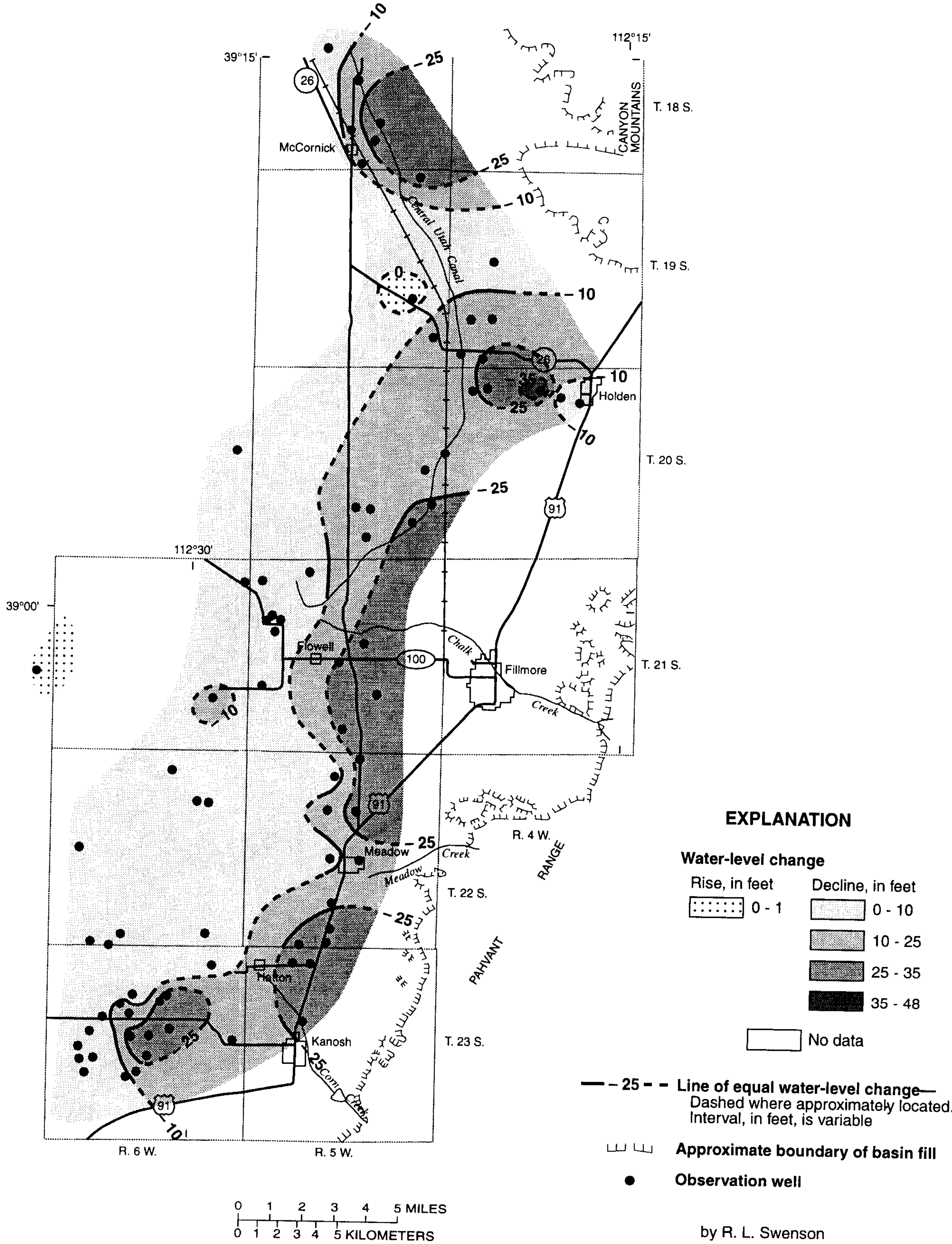


Figure 23. Map of Pahvant Valley showing change of water levels from March 1989 to March 1994.

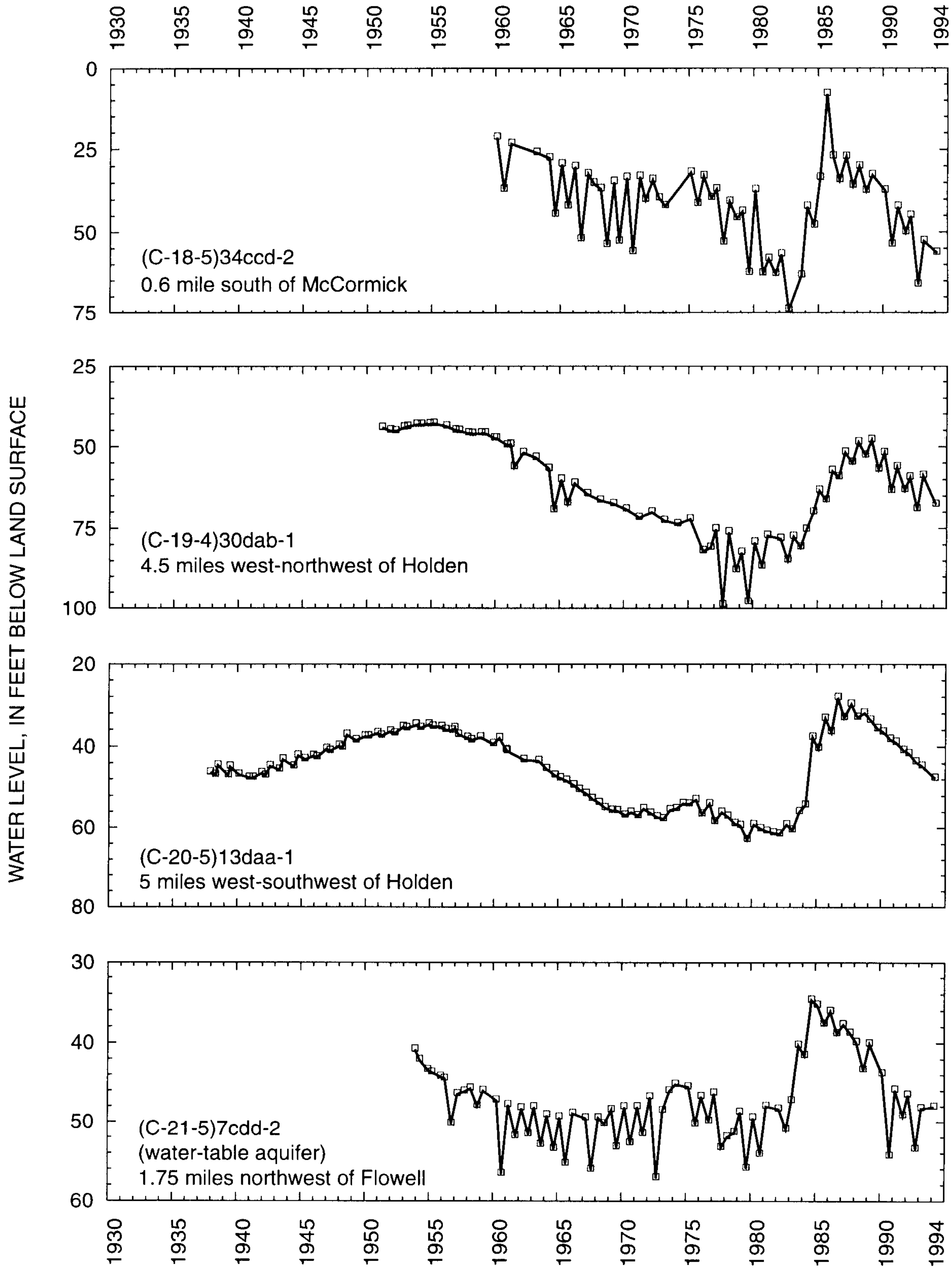


Figure 24. Relation of water levels in selected wells in Pahvant Valley to cumulative departure from the average annual precipitation at Fillmore and to annual withdrawals from wells.

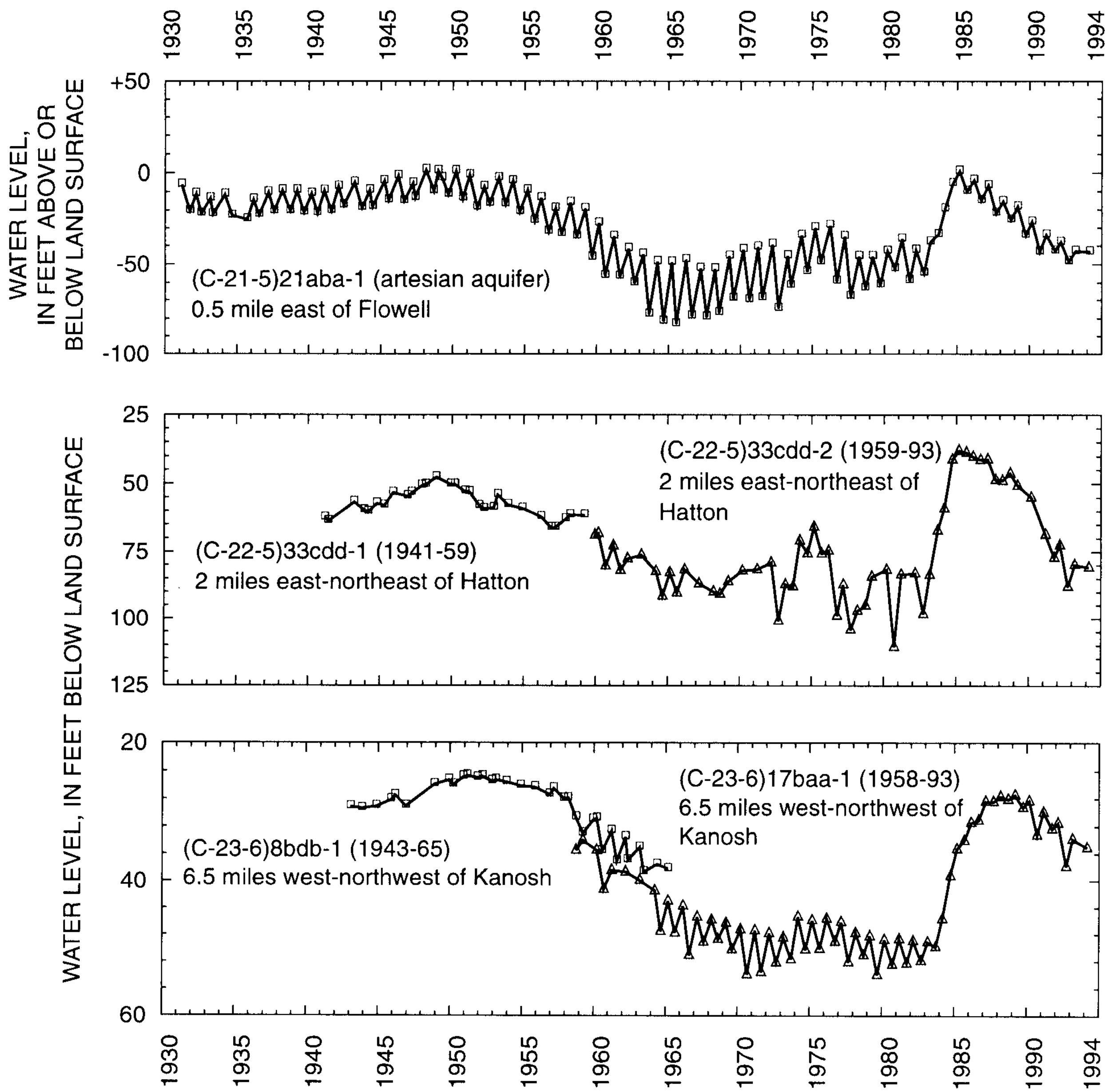


Figure 24. Relation of water levels in selected wells in Pahvant Valley to cumulative departure from the average annual precipitation at Fillmore and to annual withdrawals from wells—Continued.

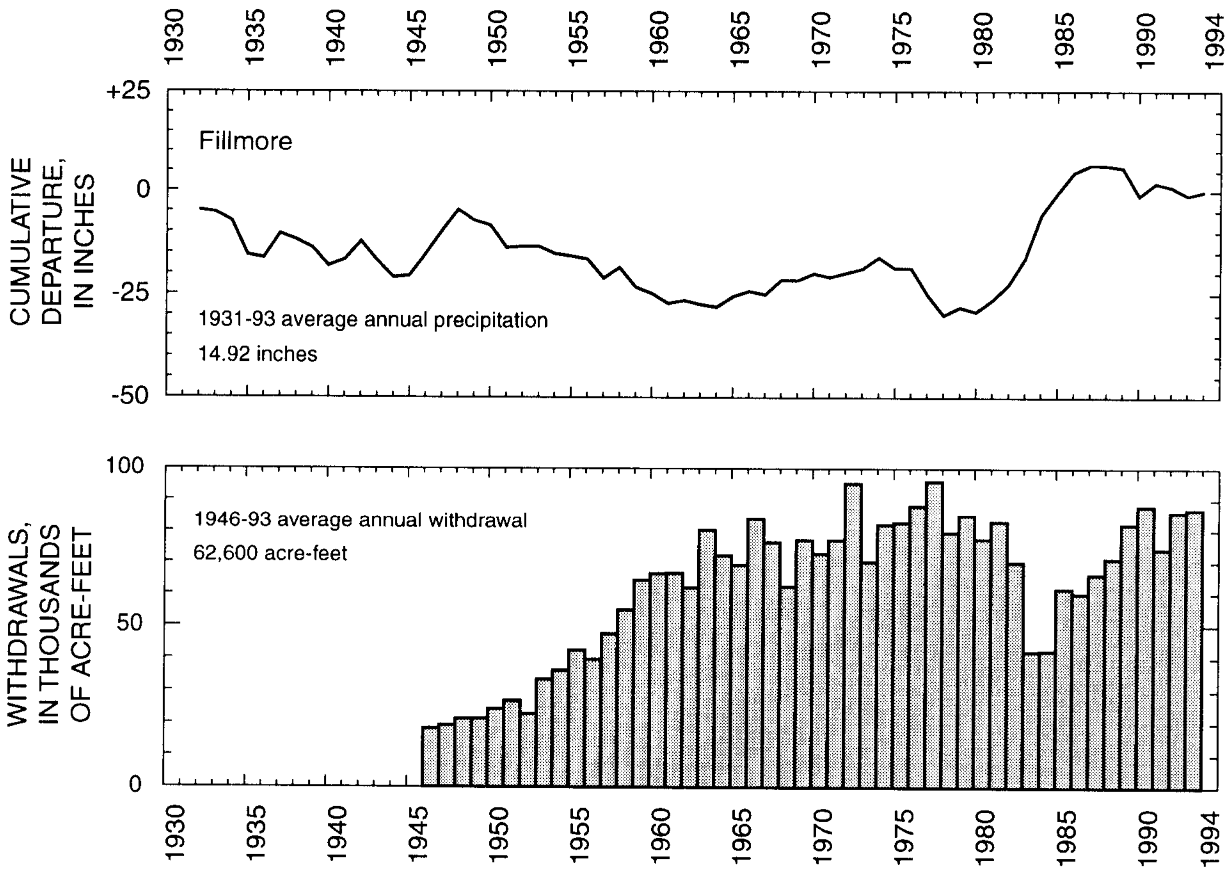


Figure 24. Relation of water levels in selected wells in Pahvant Valley to cumulative departure from the average annual precipitation at Fillmore and to annual withdrawals from wells—Continued.

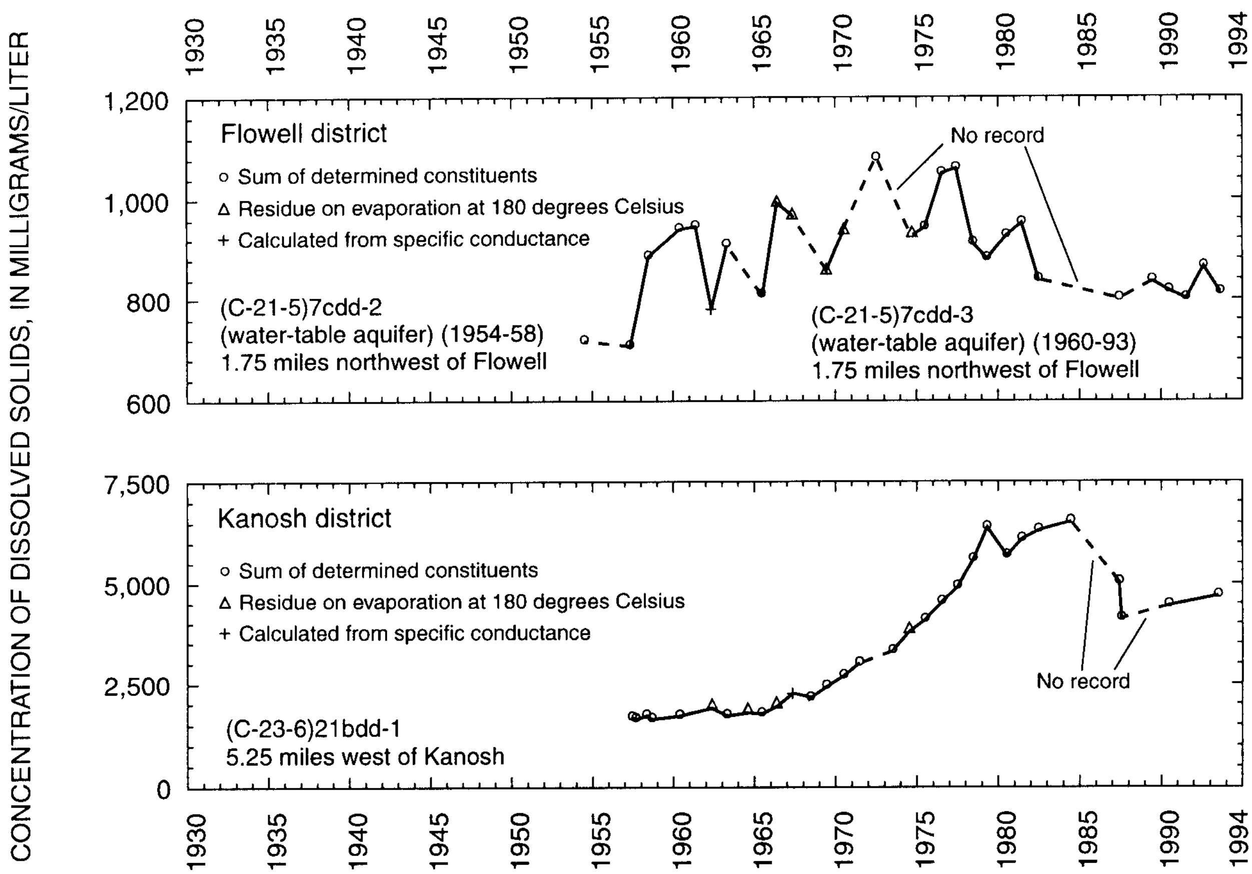


Figure 25. Concentration of dissolved solids in water from selected wells in Pahvant Valley.

CEDAR VALLEY, IRON COUNTY

by J.H. Howells

Withdrawal of water from wells in Cedar Valley, Iron County, in 1993 was about 33,000 acre-feet, which is 1,000 acre-feet less than was reported for 1992 and 8,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). Average annual withdrawal during 1989-93 was about 32,000 acre-feet, which is 11,000 acre-feet more than during the previous five-year period, 1984-88.

Ground-water levels declined from March 1989 to March 1994 in all of Cedar Valley (fig. 26). The largest decline, 17.8 feet, occurred in a well about 2 miles northwest of Cedar City. The declines probably are the result of increased withdrawals for irrigation and decreased recharge because of less precipitation and streamflow during 1989-93, as compared with the preceding five-year period, 1984-88. Discharge of Coal Creek during 1989-93 was about 77 percent of the discharge during 1984-88.

The relation of water levels in wells (C-35-11)33aac-1 and (C-37-12)34abb-1 to cumulative departure from the average annual precipitation at Cedar City FAA Airport, to discharge of Coal Creek near Cedar City, to annual withdrawals of water from wells in Cedar Valley, and to concentration of dissolved solids in water from well (C-37-12)23acb-2, is shown in figure 27. Precipitation at Cedar City FAA Airport in 1993 was 11.46 inches, which is 0.07 inch less than precipitation for 1992 and 0.69 inch more than the average annual precipitation for 1951-93. Average annual precipitation for 1989-93 was 9.99 inches, 2.80 inches less than the average annual precipitation in the previous five-year period, 1984-88.

Discharge of Coal Creek was about 50,250 acre-feet in 1993, approximately 32,600 acre-feet more than the revised value for 1992, and about 26,200 acre-feet more than the average annual discharge during 1939-93. The average annual discharge of Coal Creek during 1989-93 was about 20,900 acre-feet, approximately 6,100 acre-feet less than the average annual discharge for the previous five-year period, 1984-88. The concentration of dissolved solids in water from well (C-37-12)23acb-2 increased slightly from the 1992 level.

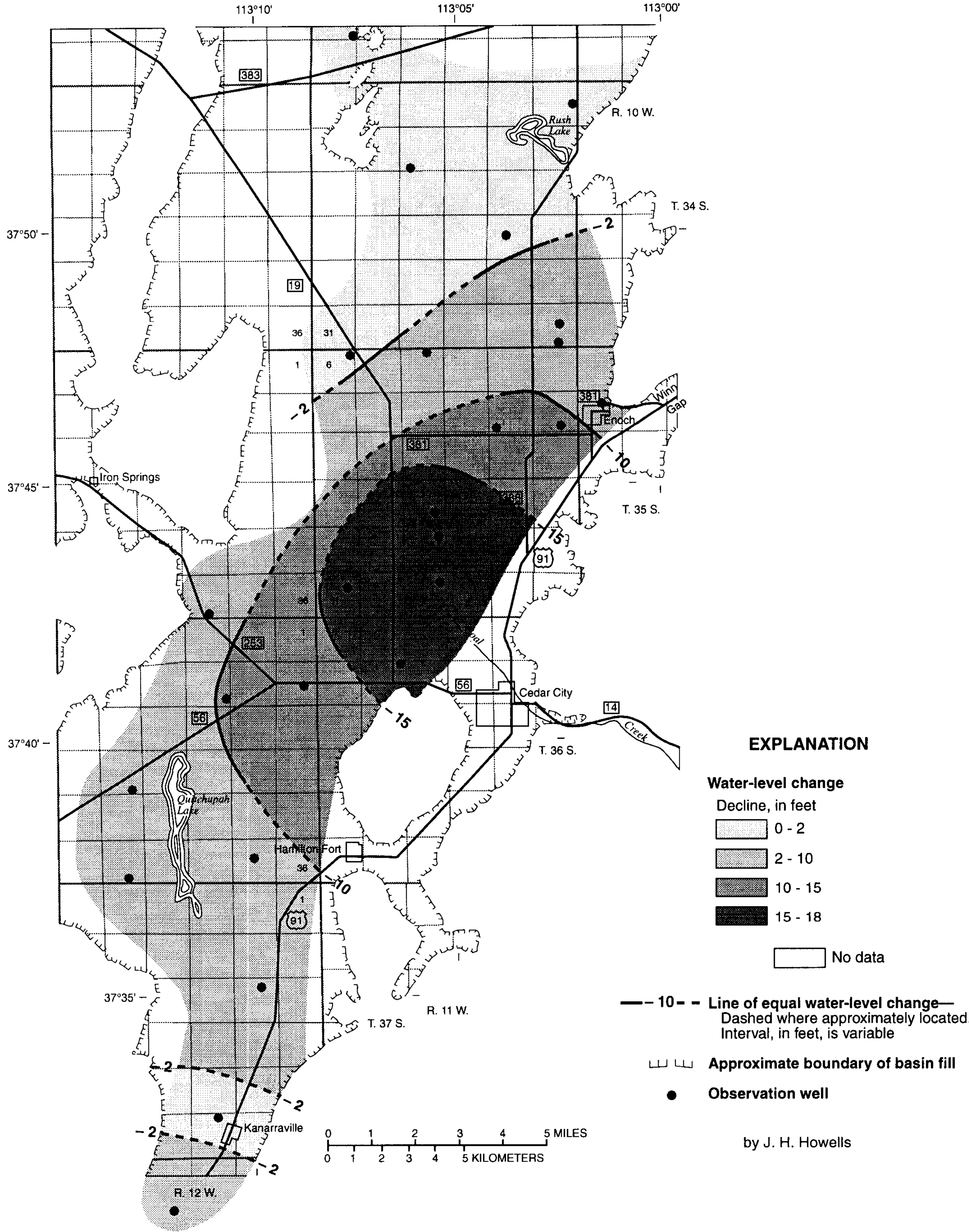


Figure 26. Map of Cedar Valley, Iron County, showing change of water levels from March 1989 to March 1994.

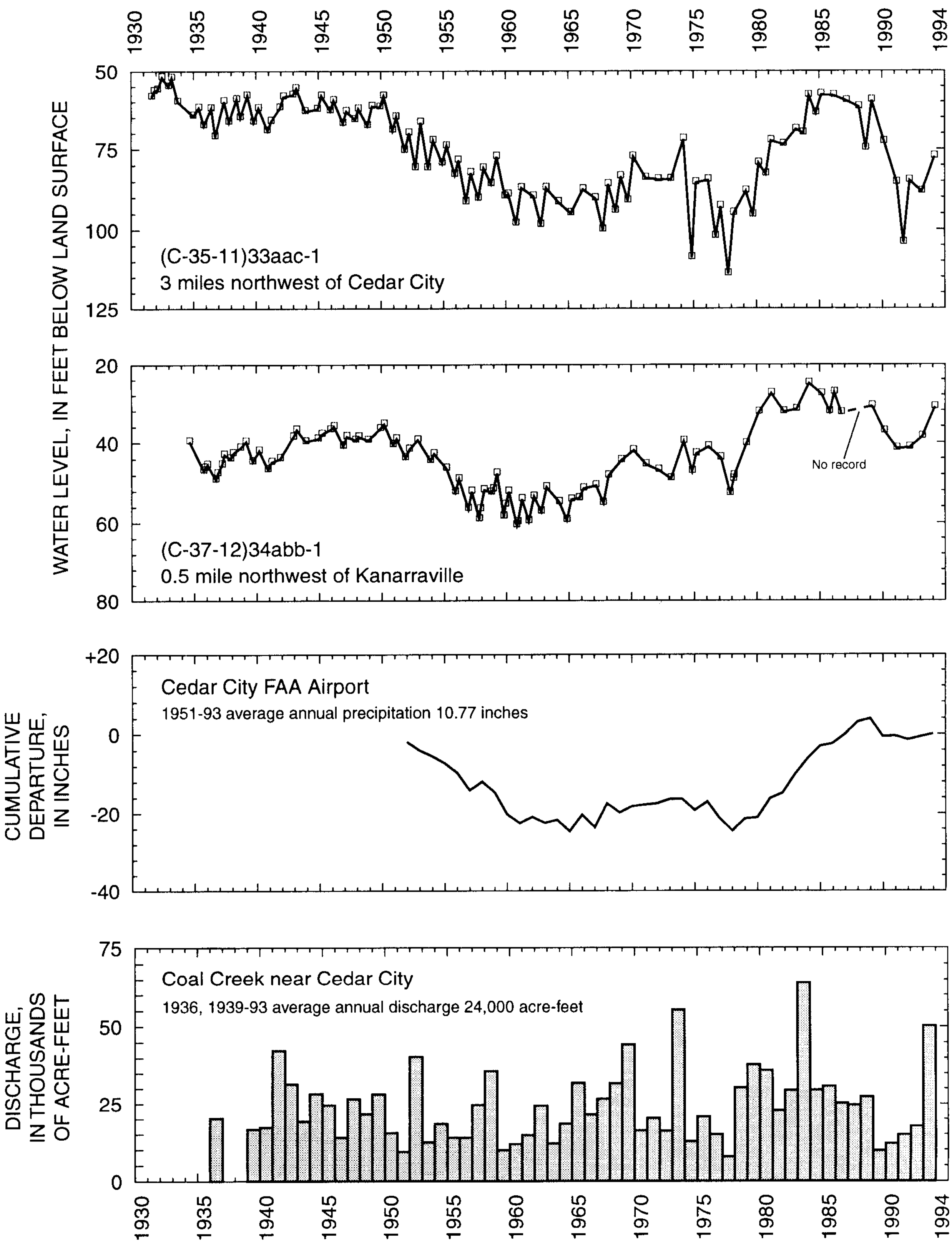


Figure 27. Relation of water levels in selected wells in Cedar Valley, Iron County, to cumulative departure from the average annual precipitation at Cedar City FAA Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-37-12)23acb-2.

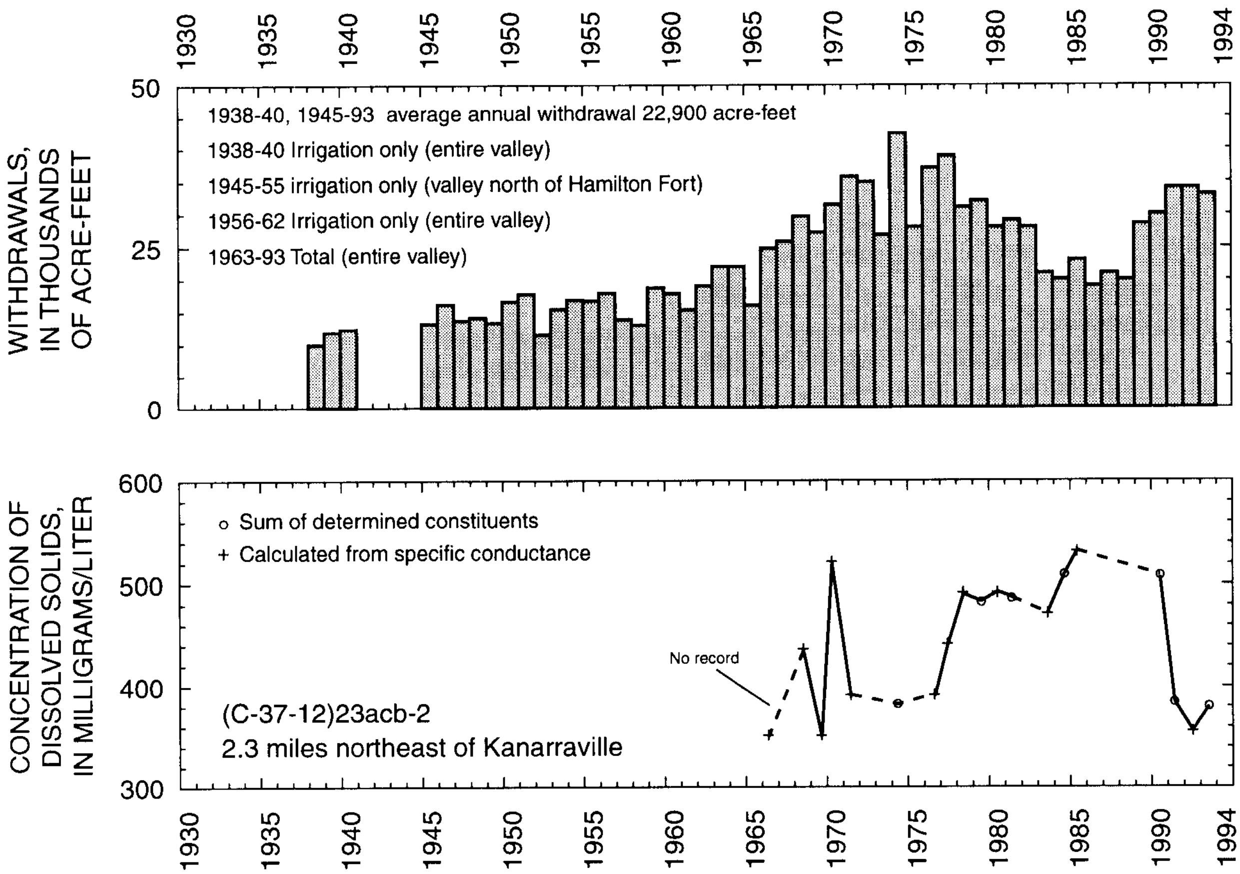


Figure 27. Relation of water levels in selected wells in Cedar Valley, Iron County, to cumulative departure from the average annual precipitation at Cedar City FAA Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-37-12)23acb-2—Continued.

PAROWAN VALLEY

by J.H. Howells

Withdrawal of water from wells in Parowan Valley was about 28,000 acre-feet in 1993. This was about 3,000 acre-feet less than in 1992 and 2,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for 1989-93 was about 30,000 acre-feet, 7,000 acre-feet more than the average annual withdrawal for the preceding five-year period, 1984-88. The decrease in withdrawals from 1992 to 1993 was because of less withdrawals for irrigation.

Water levels declined from March 1989 to March 1994 in all parts of Parowan Valley for which data are available (fig. 28). The largest declines, from 34 to 53 feet, occurred in an area northwest of Parowan and west of Paragonah. The decline in water levels probably is the result of greater withdrawals and less recharge because of less precipitation during 1989-93 as compared with the preceding five-year period, 1984-88.

The relation of water levels in wells (C-34-8)5bca-1 and (C-34-10)24cbc-2 to cumulative departure from the average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1 is shown in figure 29. Precipitation at Parowan Power Plant was 12.85 inches in 1993, 0.46 inch more than the average annual precipitation for 1935-93. The average annual precipitation for 1989-93 at Parowan Power Plant was 11.95 inches, 2.81 inches less than the average annual precipitation for the preceding five-year period, 1984-88. The concentration of dissolved solids in water from well (C-33-8)31ccc-1 has shown little change since 1976.

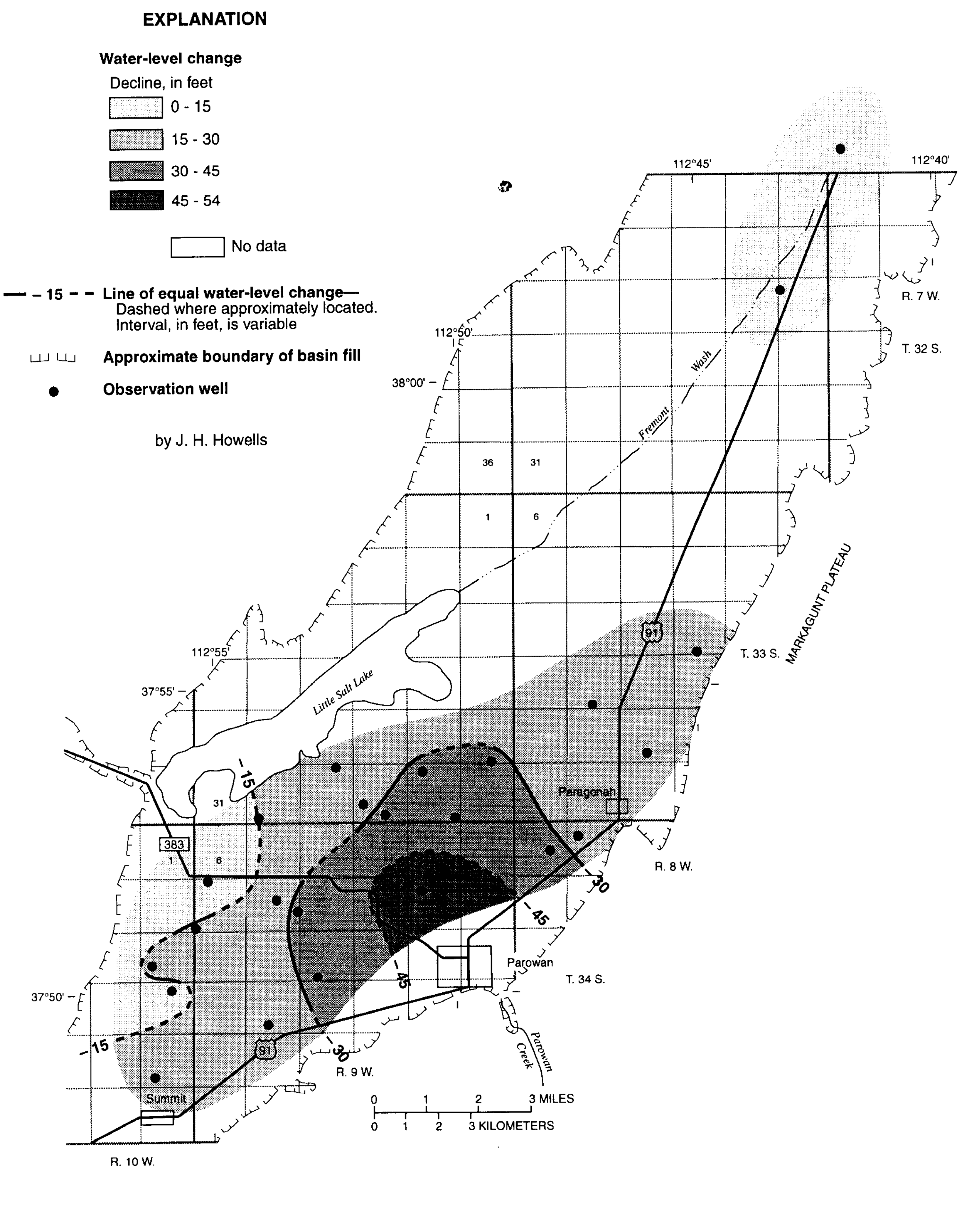


Figure 28. Map of Parowan Valley showing change of water levels from March 1989 to March 1994.

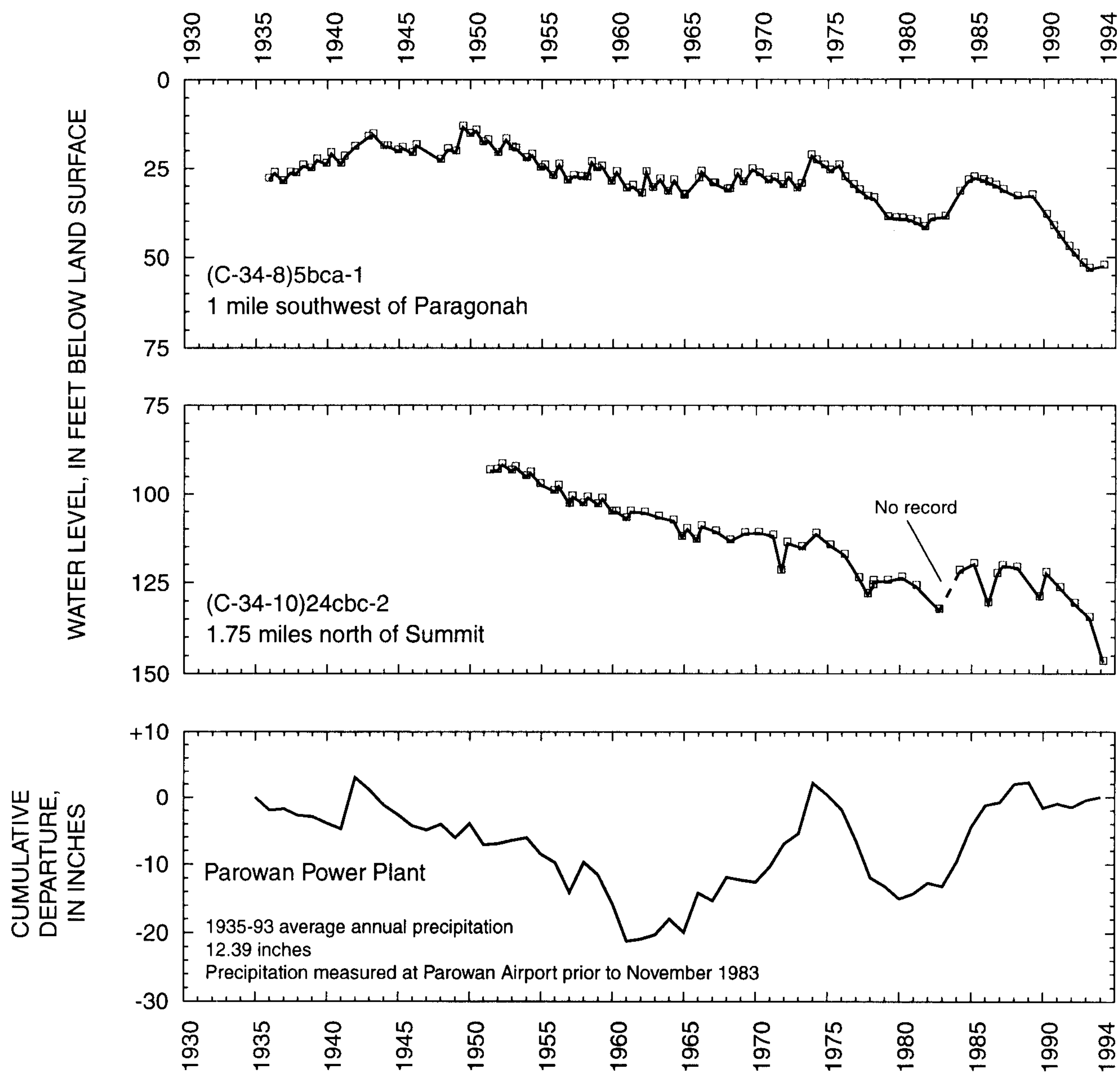


Figure 29. Relation of water levels in selected wells in Parowan Valley to cumulative departure from the average annual precipitation at Parowan Power Plant, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1.

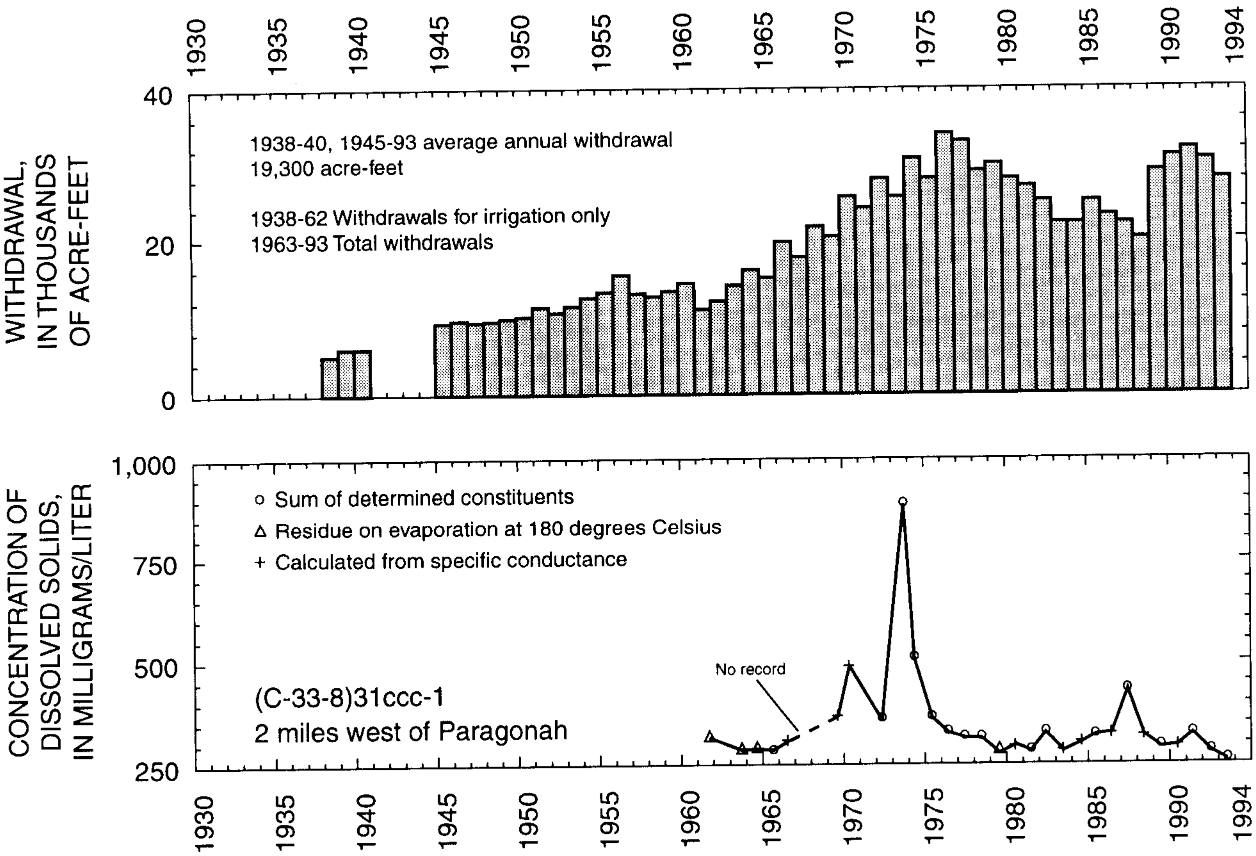


Figure 29. Relation of water levels in selected wells in Parowan Valley to cumulative departure from the average annual precipitation at Parowan Power Plant, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1—Continued.

ESCALANTE VALLEY

Milford Area

by B.A. Slaugh

Withdrawal of water from wells in the Milford area of the Escalante Valley in 1993 was about 50,000 acre-feet, 8,000 acre-feet more than in 1992, and 6,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for 1989-93, 48,000 acre-feet, was 6,000 acre-feet more than for the preceding five-year period, 1984-88. Withdrawals increased each year from 1988 to 1991, decreased in 1992, and increased again in 1993.

Water levels declined in most of the Milford area from March 1989 to March 1994 with the greatest decline, about 19 feet, measured in a well 5 miles southeast of Milford (fig. 30). Declines in water levels probably resulted from less recharge because of less precipitation and less streamflow in the Beaver River during 1989-93 than during the preceding five-year period, and from more withdrawals of water from wells during 1989-93, as compared with the preceding five-year period, 1984-88. Water levels rose almost 3 feet in northeastern part of the valley.

The relation of water levels in selected wells to cumulative departure from the average annual precipitation at Black Rock, to discharge of the Beaver River at Rocky Ford Dam, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1 is shown in figure 31. Precipitation at Black Rock in 1993 was 10.02 inches, 1.98 inches more than the quantity reported for 1992 and 1.07 inches more than the 1952-93 average annual precipitation. The average annual precipitation at Black Rock during 1989-93, 8.59 inches, was 1.79 inches less than the average during 1984-88.

Discharge of the Beaver River in 1993 was about 27,300 acre-feet, approximately 12,500 acre-feet more than the 1992 discharge and about 1,900 acre-feet less than the 1931-93 average annual discharge. The average annual discharge for 1989-93 was about 18,400 acre-feet, which was approximately 33,300 acre-feet less than the average discharge for 1984-88. The concentration of dissolved solids in water from well (C-28-11)25dcd-1 has increased from less than 600 milligrams per liter in the 1950's to about 1,600 milligrams per liter in 1986, then declined to about 1,300 milligrams per liter in 1993.

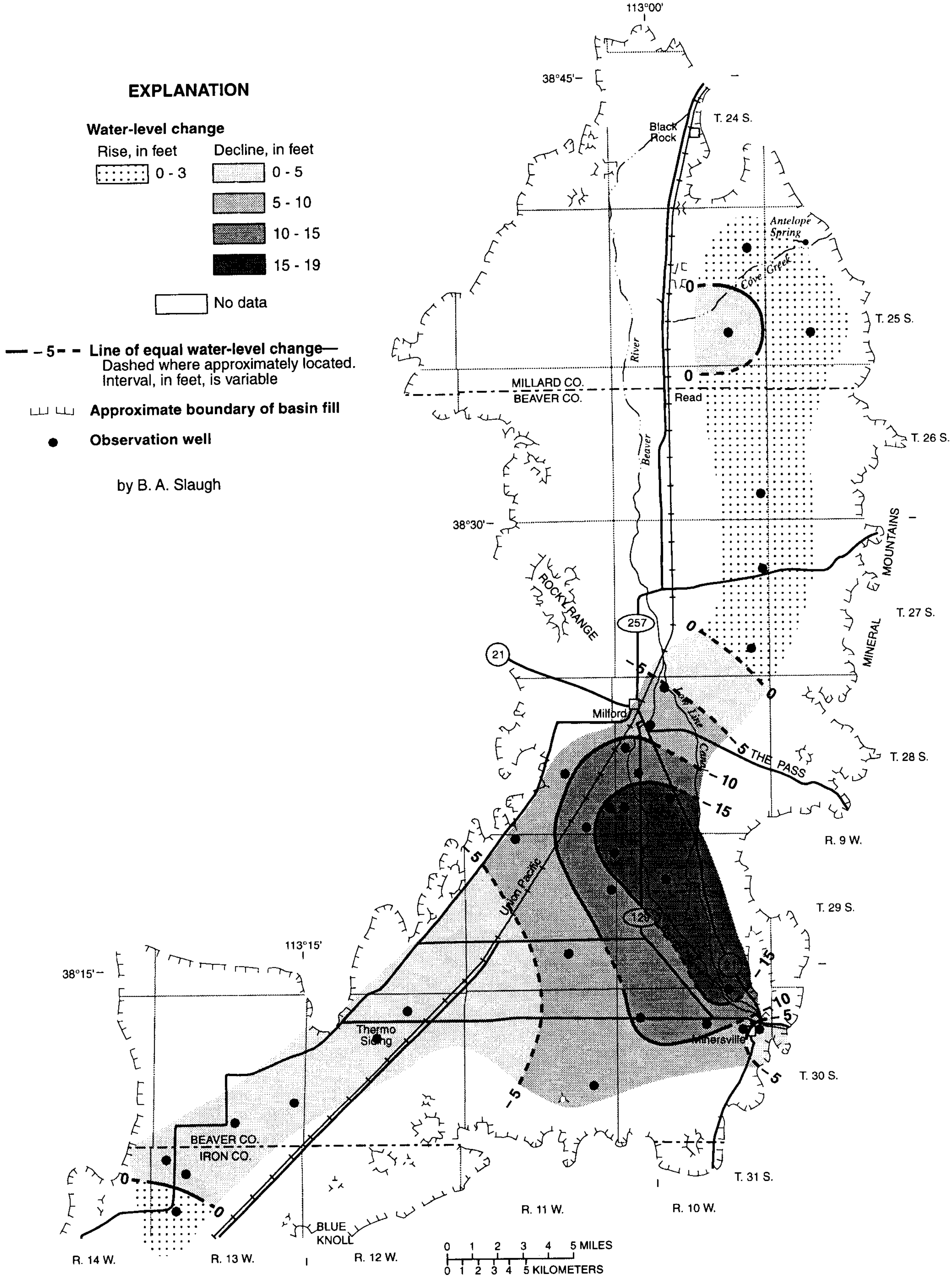


Figure 30. Map of the Milford area showing change of water levels from March 1989 to March 1994.

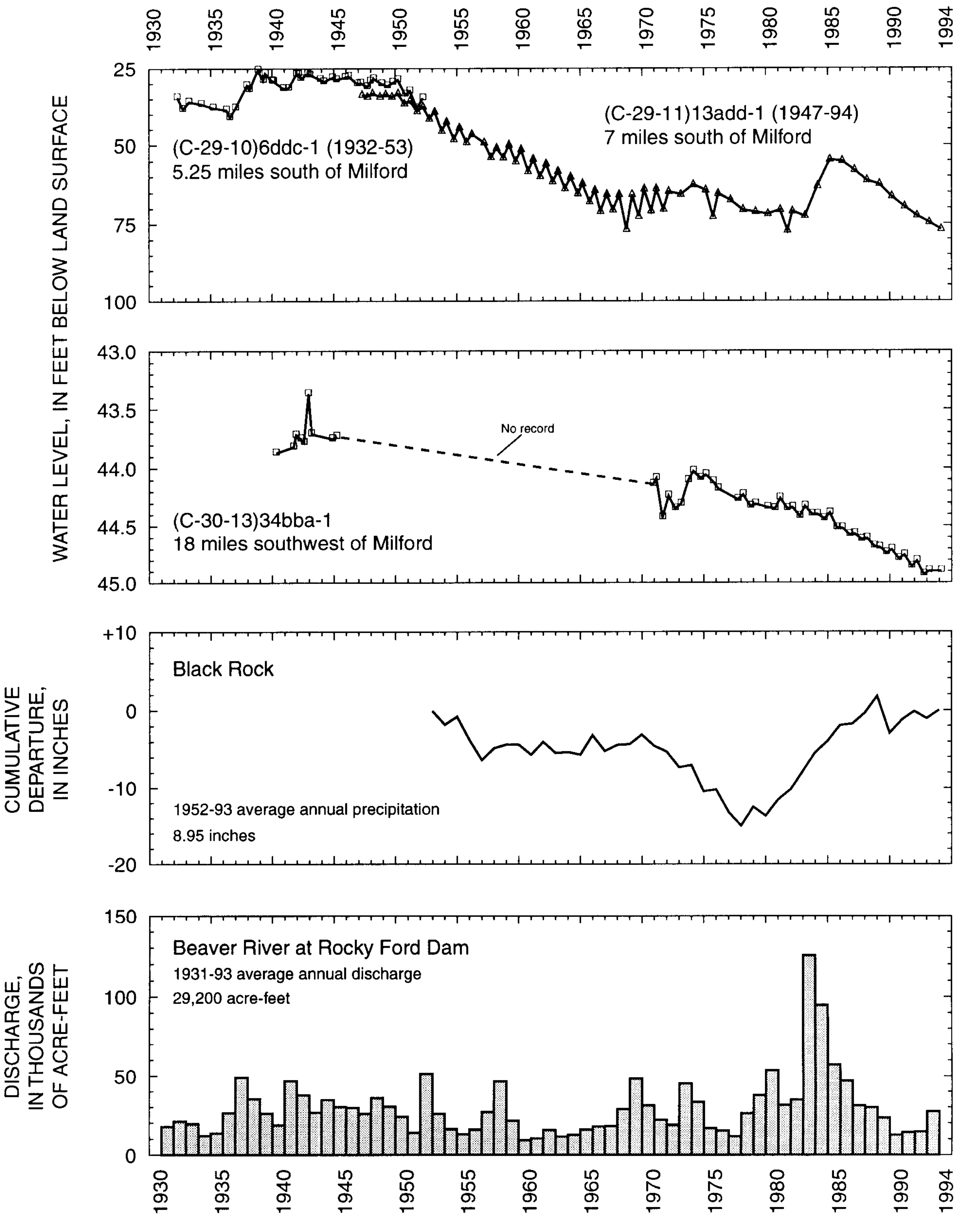


Figure 31. Relation of water levels in selected wells in the Milford area to cumulative departure from the average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1.

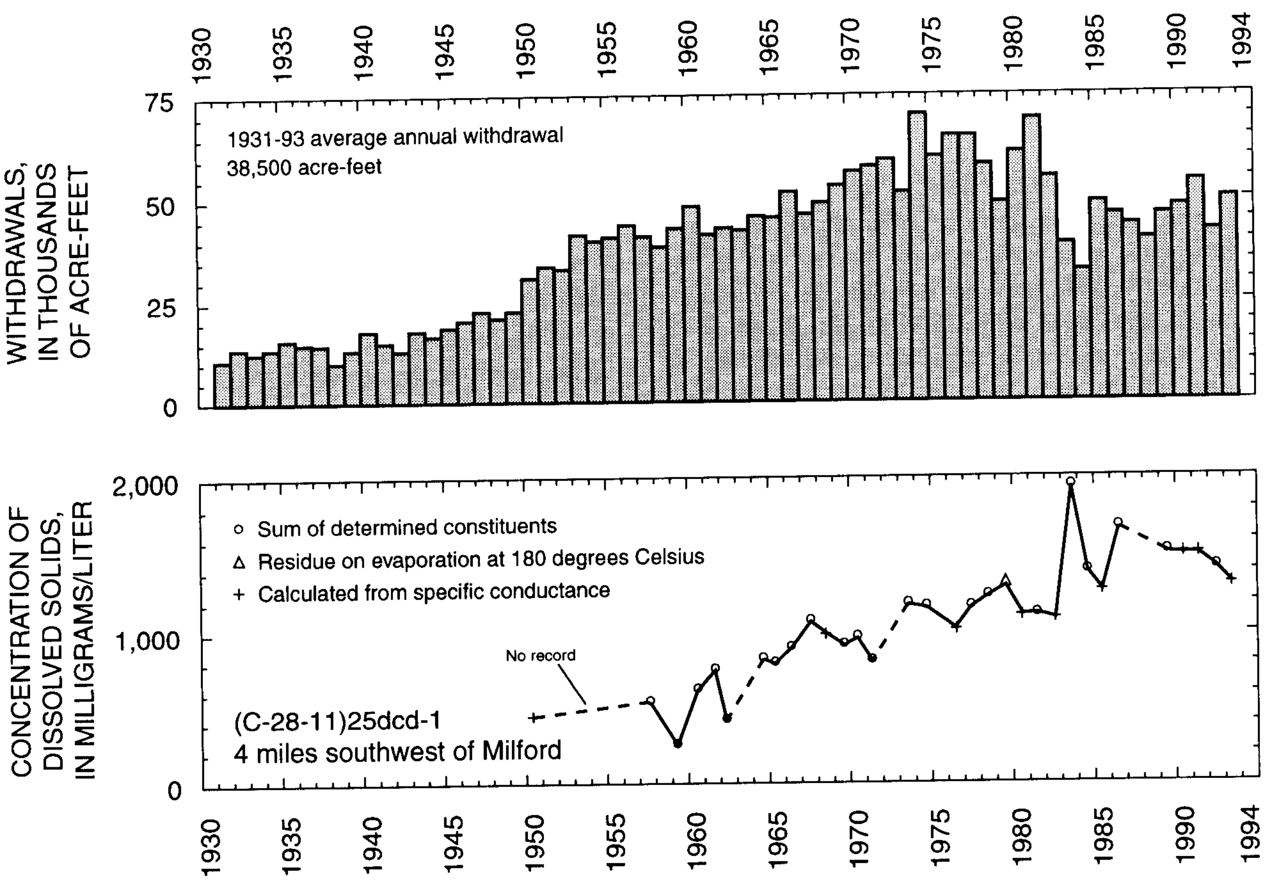


Figure 31. Relation of water levels in selected wells in the Milford area to cumulative departure from the average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.

ESCALANTE VALLEY

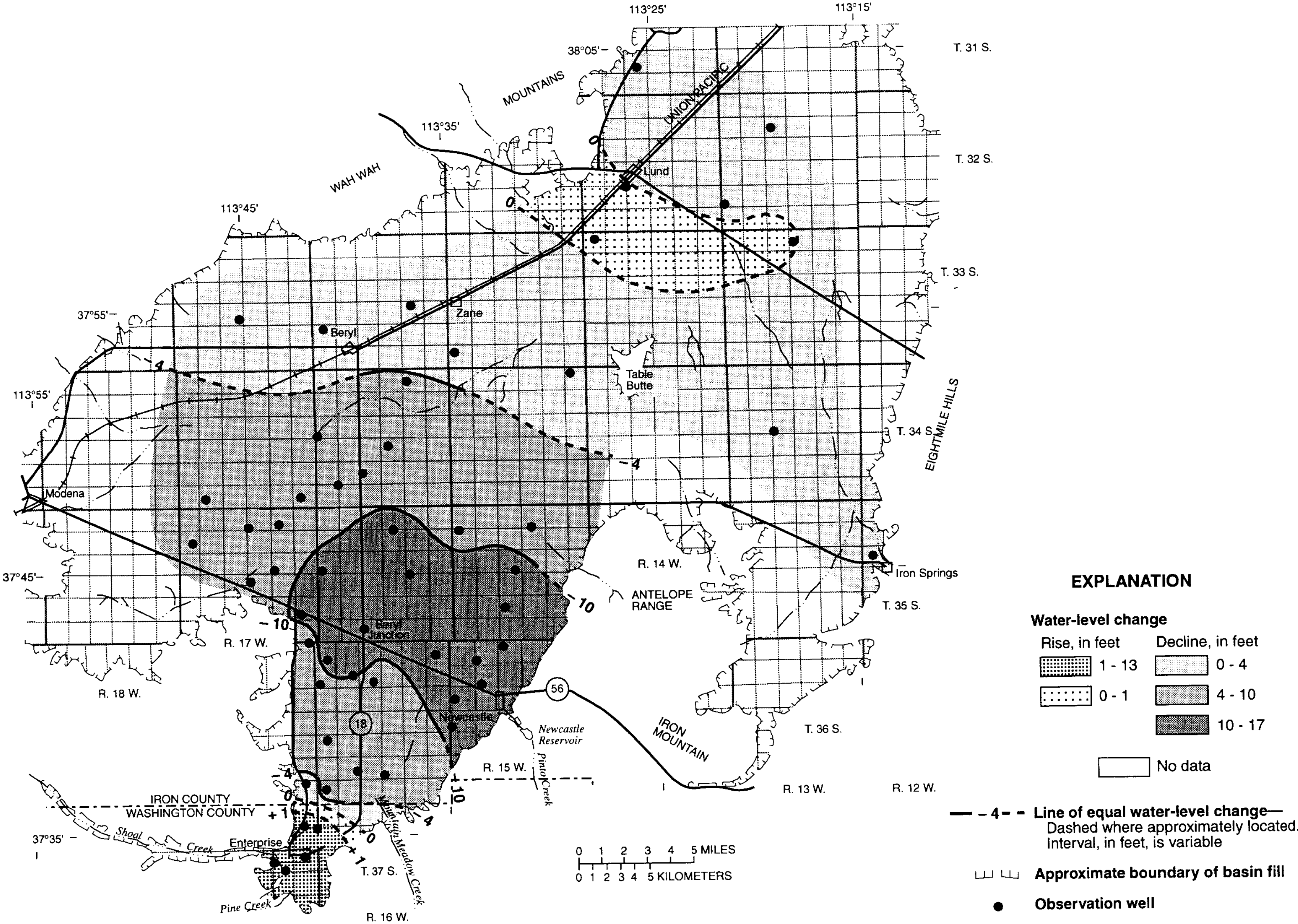
Beryl-Enterprise Area

by H.K. Christiansen

Withdrawal of water from wells in the Beryl-Enterprise area was about 78,000 acre-feet in 1993, 6,000 acre-feet more than was reported in 1992, and about 10,000 acre-feet less than the average annual withdrawal for 1983-92 (tables 2 and 3). The average annual withdrawal for the 1989-93 period, 80,000 acre-feet, was 15,000 acre-feet less than the average annual withdrawal for the preceding five-year period, 1984-88.

Water levels declined from March 1989 to March 1994 in most of the Beryl-Enterprise area; however, water levels rose slightly in the southern part of the valley near Enterprise (fig. 32). The overall declines are primarily the result of continued large withdrawals for irrigation and possibly less recharge because of less precipitation during 1989-93 than during the preceding five-year period, 1984-88. The largest declines, about 10 to 17 feet, were measured north and southeast of Beryl Junction. Withdrawals of water during 1981-88 from a mine about 6 miles north of Enterprise were diverted to the area north of Beryl Junction and used to recharge the ground-water system. These withdrawals and the resulting recharge ceased in December 1988.

The relation of water levels in selected wells in the Beryl-Enterprise area to cumulative departure from the average annual precipitation at Modena, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2 is shown in figure 33. The 1993 precipitation at Modena was 12.75 inches, 2.43 inches more than the average annual precipitation for 1936-93. The average annual precipitation during 1989-93, 10.20 inches, was 2.20 inches less than the average for 1984-88. The water level in well (C-35-17)36dcc-1 generally has declined from 1948 to 1993. The concentration of dissolved solids in water from well (C-34-16)28dcc-2 increased from about 460 milligrams per liter in 1967 to about 680 milligrams per liter in 1993.



by H. K. Christiansen

Figure 32. Map of the Beryl-Enterprise area showing change of water levels from March 1989 to March 1994.

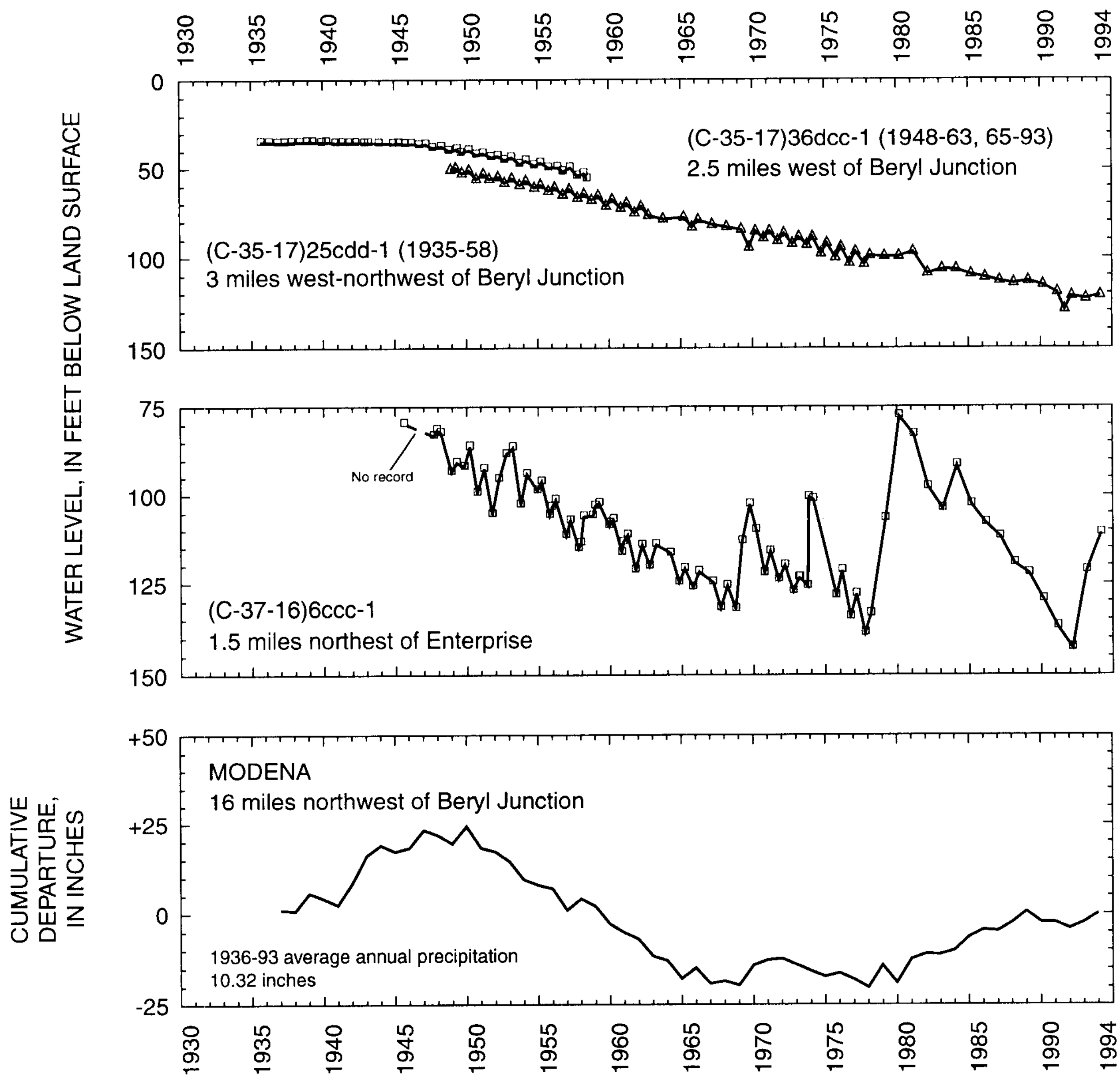


Figure 33. Relation of water levels in selected well in the Beryl-enterprise area to cumulative departure from the average annual precipitation at Modena, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2.

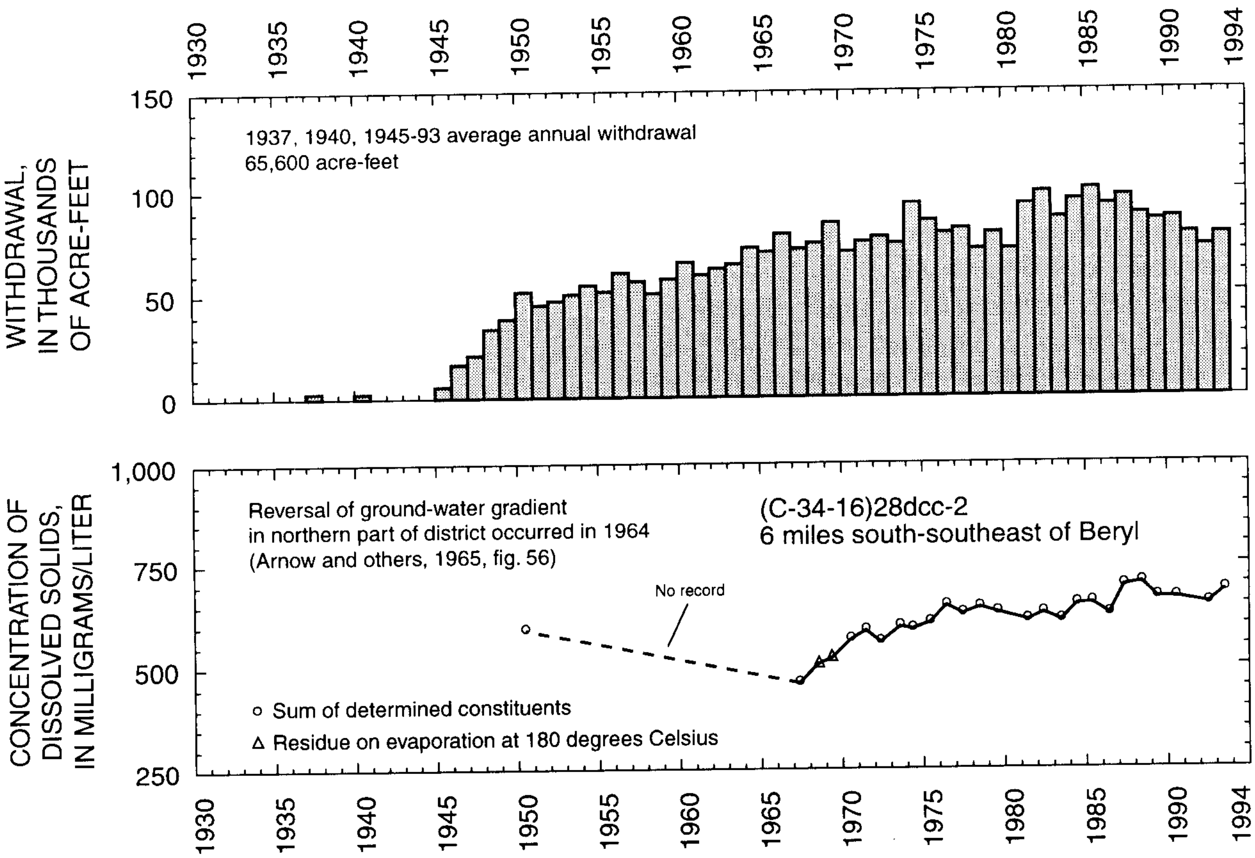


Figure 33. Relation of water levels in selected well in the Beryl-enterprise area to cumulative departure from the average annual precipitation at Modena, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.

CENTRAL VIRGIN RIVER AREA

by H.K. Christiansen

Withdrawal of water from wells in the central Virgin River area was about 13,000 acre-feet in 1993, 1,000 acre-feet less than reported in 1992, and 6,000 acre-feet less than the average annual withdrawal for 1983-92 (tables 2 and 3). This includes water withdrawn from valley-fill aquifers that is used primarily for irrigation and water withdrawn from consolidated rock and valley fill, most of which is used for public supply. Withdrawals for irrigation in 1993 decreased 600 acre-feet from 1992 and withdrawals for industry increased about 50 acre-feet for the same period. Withdrawals for public supply increased about 200 acre-feet from the 1992 estimate. The average annual withdrawal for 1989-93, 17,000 acre-feet, was about 3,000 acre-feet less than the average for the preceding five-year period,1984-88.

Water levels rose in most of the central Virgin River area from February 1989 to February 1994 and in the Leeds area (fig. 34). The greatest rise, about 3.3 feet, occurred at Leeds. The rises probably are the result of local decreases in withdrawals for irrigation, and greater-than-average precipitation and streamflow in 1993. Water levels declined in areas west and southeast of St. George and west of Hurricane, with the largest decline of about 18 feet in the area along Ft. Pierce Wash. The decline in water levels probably is the result of less recharge because of less precipitation and surface-water flow during 1989-93 than during the preceding five year period, 1984-88.

The relation of water levels in selected wells to discharge of the Virgin River at Virgin, to cumulative departure from the average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1 is shown in figure 35. Discharge of the Virgin River at Virgin was about 266,800 acre-feet in 1993, which is approximately 163,800 acre-feet more than the revised value of 103,000 acre-feet for 1992 and about 131,200 acre-feet more than the long-term average. The 1989-93 average annual discharge of about 119,800 acre-feet was 1,100 acre-feet less than during the preceding five-year period, 1984-88. Precipitation at St. George in 1993 was 11.09 inches, which is 3.19 inches more than the average annual precipitation for 1947-93. The average annual precipitation during 1989-93, 7.37 inches, was 1.08 inches less than the average for the preceding five-year period, 1984-88. The graph of concentration of dissolved solids in water from well (C-41-17)17cba-1 indicates little change since 1966.

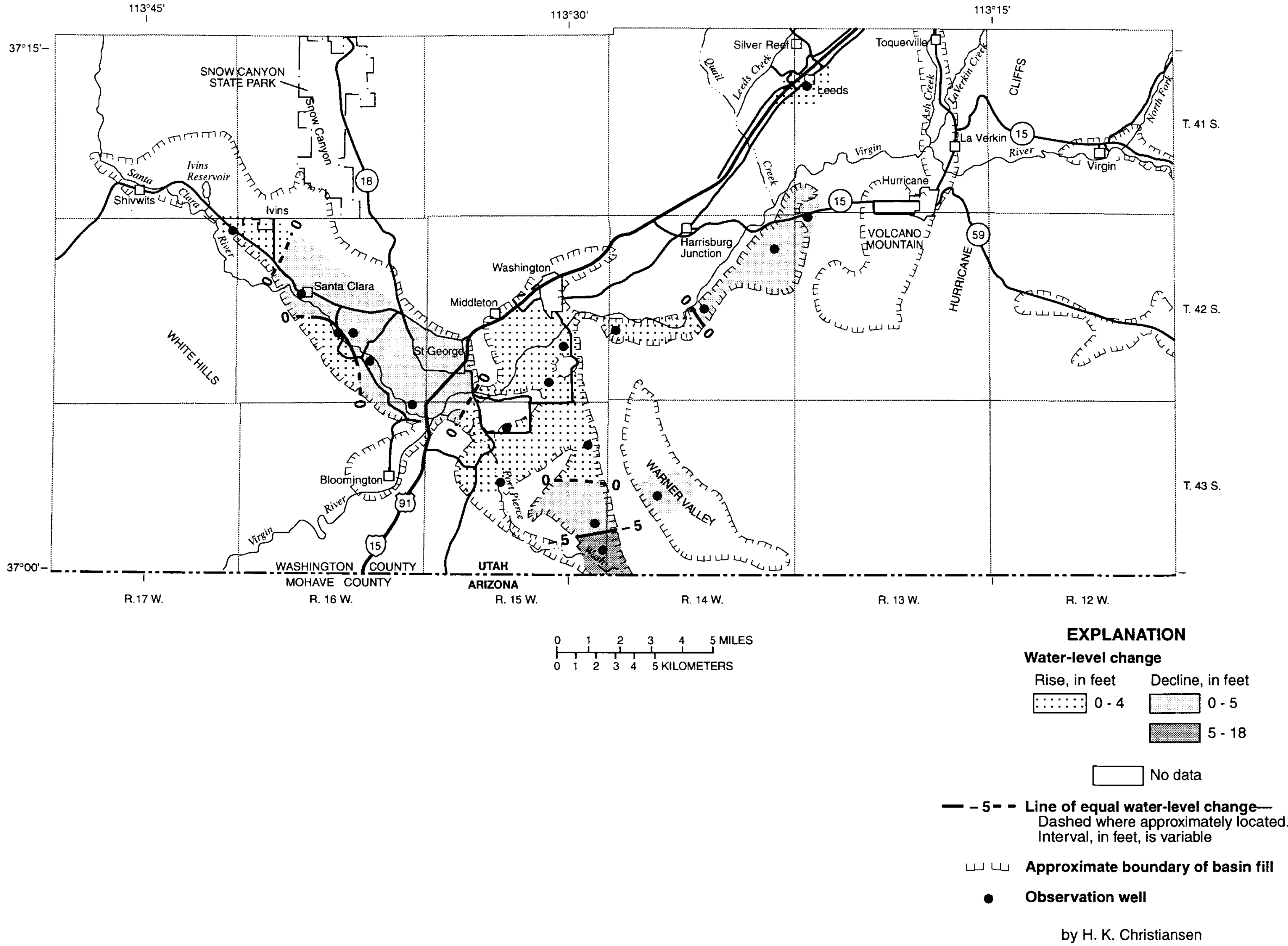


Figure 34. Map of the central Virgin River area showing change of water levels from February 1989 to February 1994.

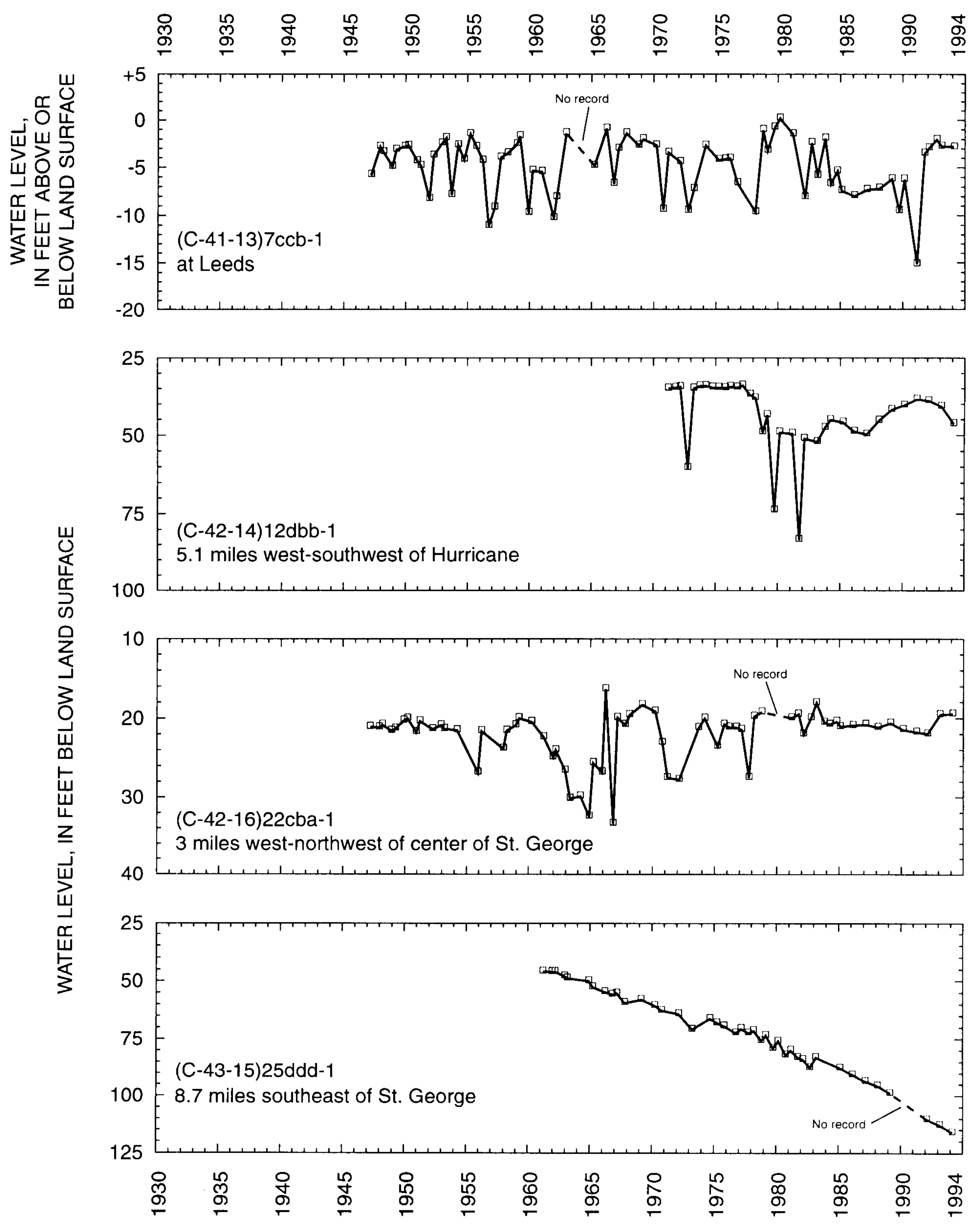


Figure 35. Relation of water levels in selected wells in the central Virgin River area, to annual discharge of the Virgin River at Virgin, to cumulative departure from the average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1.

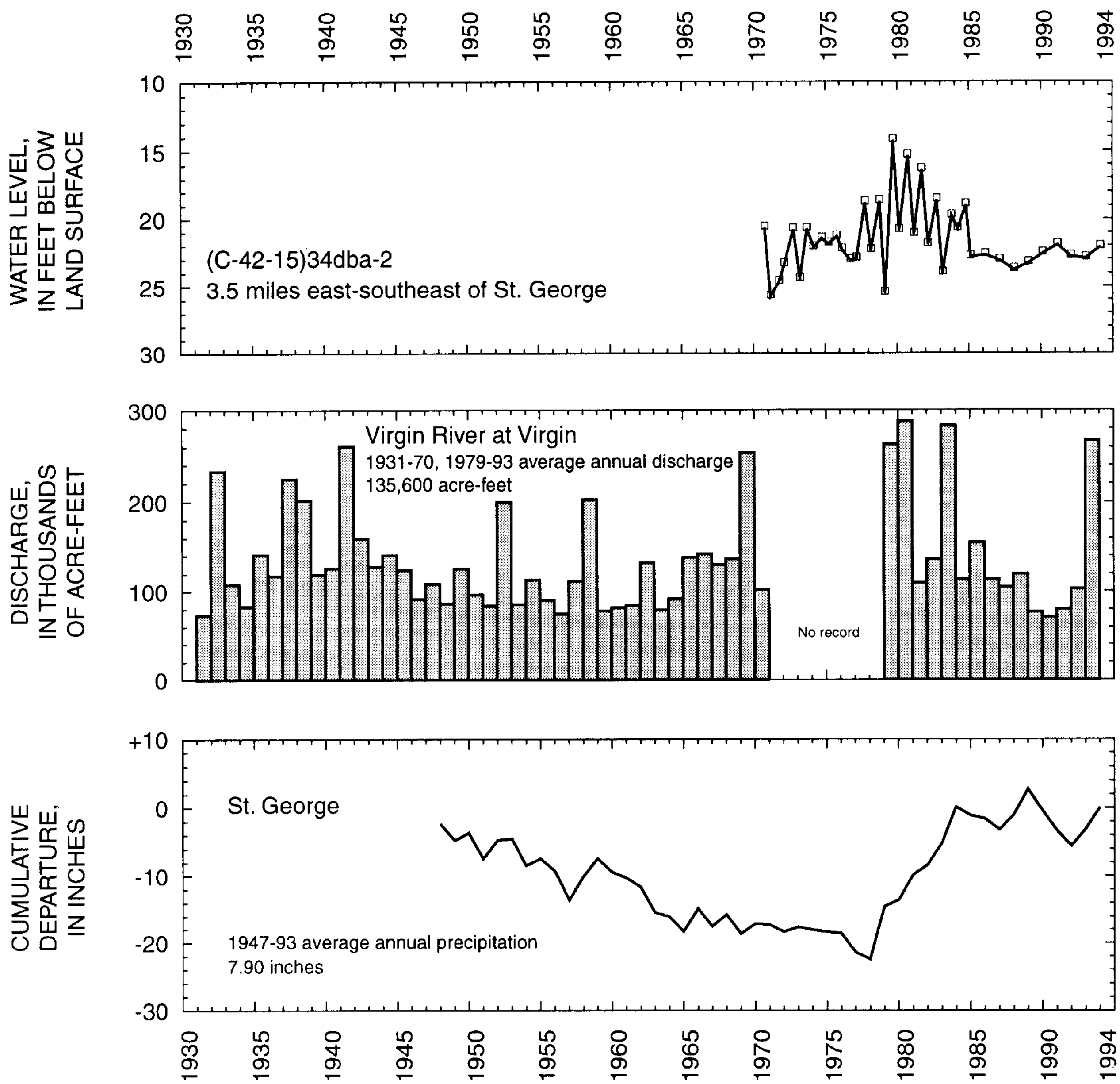


Figure 35. Relation of water levels in selected wells in the central Virgin River area, to annual discharge of the Virgin River at Virgin, to cumulative departure from the average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.

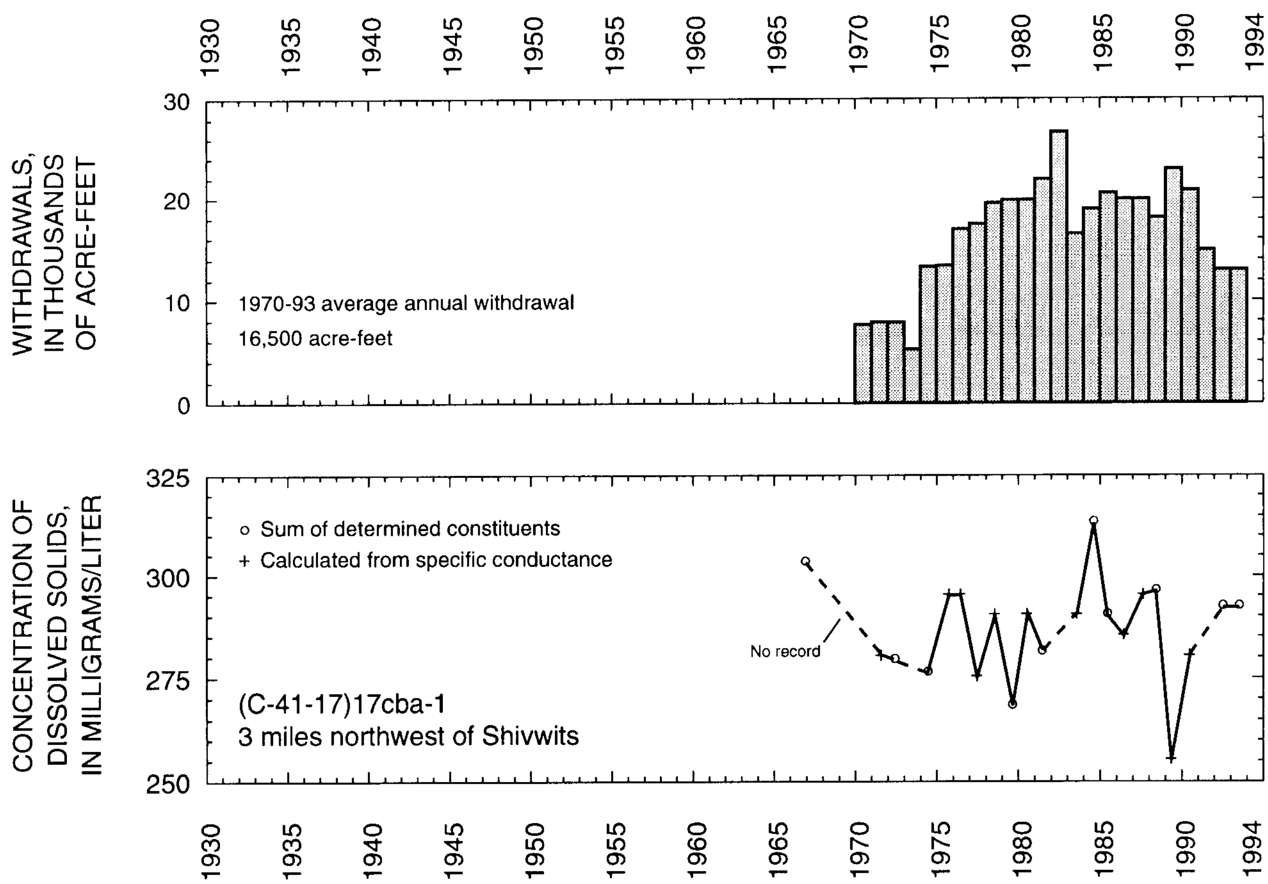


Figure 35. Relation of water levels in selected wells in the central Virgin River area, to annual discharge of the Virgin River at Virgin, to cumulative departure from the average annual precipitation at St. George, to annual withdrawals from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.

OTHER AREAS

by A.D. Bagley

Approximately 93,000 acre-feet of water was withdrawn from wells in 1993 in those areas of Utah listed below:

Number in figure 1	Area	Estimated withdrawal (acre-feet) 1992	1993
1	Grouse Creek Valley	3,100	2,900
2	Park Valley	2,800	2,400
8	Ogden Valley	12,600	11,700
13	Dugway Area, Skull Valley, and Old River Bed	5,400	3,700
14	Cedar Valley, Utah County	2,600	3,000
19	Sanpete Valley	16,300	8,800
24	Snake Valley	12,200	11,500
26	Beaver Valley	7,900	7,100
	Remainder of state	57,200	41,900
Total (rounded)		120,000	93,000

The total withdrawal was 27,000 acre-feet less in 1993 than in 1992 and 4,000 acre-feet more than the average annual withdrawal for 1983-92 (tables 2 and 3). In the areas listed, withdrawals in 1993 were less than they were in 1992, except in Cedar Valley (Utah County). The decrease in total withdrawal mainly was because of decreased withdrawals for irrigation and public supply. The average annual withdrawal for 1989-93 was 107,000 acre-feet, 28,000 acre-feet more than the average for the preceding five-year period, 1984-88.

Water-level changes in Cedar Valley (Utah County) are shown in figure 36. Water levels declined from March 1989 to March 1994 along the west side of Cedar Valley because of less-than-average precipitation resulting in less recharge during 1989-93 than during the preceding five year period, 1984-88. The average annual precipitation at Fairfield during 1989-1993 was 11.43 inches, 0.21 inch less than the long term annual average and 1.73 inches less than the average for the preceding five-year period, 1984-88. Rises in water levels along the east side of the valley may be the result of increased local recharge.

Water levels in Sanpete Valley from March 1989 to March 1994 generally rose in the northeast and southern portions of the valley, with small local areas of water level rises in the center of the valley (fig. 37). Water levels generally declined in the central and northwest parts of the valley. The rise in water levels in the Sanpete Valley is a result of greater-than-average precipitation and decreased withdrawals in 1993.

The precipitation for 1993 at Manti was 14.73 inches, 1.56 inches greater than the long term average and 1.91 inches more than the 1988-93 average. The average annual precipitation at Manti during 1989-93 was 12.82 inches, 1.38 inches less than the preceding five-year period, 1984-88. In 1993, the withdrawal of ground water from wells was about 8,800 acre-feet, 7,500 acre-feet less than in 1992. The average annual withdrawal during 1989-93 was about 14,000 acre-feet, 4,900 acre-feet more than for 1984-88.

The relation of water levels in 21 selected observation wells to the cumulative departure from the average annual precipitation at 18 sites in or near those areas is shown in figure 38. Water levels from March 1989 to March 1994 declined in 15 and rose in 6 of the 21 observation wells. The declines were because of less recharge because of less-than-average precipitation and larger-than-average withdrawals of water from wells during 1989-93 than during 1984-88 (table 3). Average annual precipitation during 1989-93 was less than the 1984-88 period at 15 of the 18 precipitation sites.

Hydrographs for two selected wells in the Park City area are included in this report for the first time. The water level in well (D-2-4)8aaa-1 has fluctuated about 10 feet but declined less than 1 foot overall since April of 1989. The water level in well (D-1-4)20bcb-1 has declined about 2.5 feet since June of 1983.

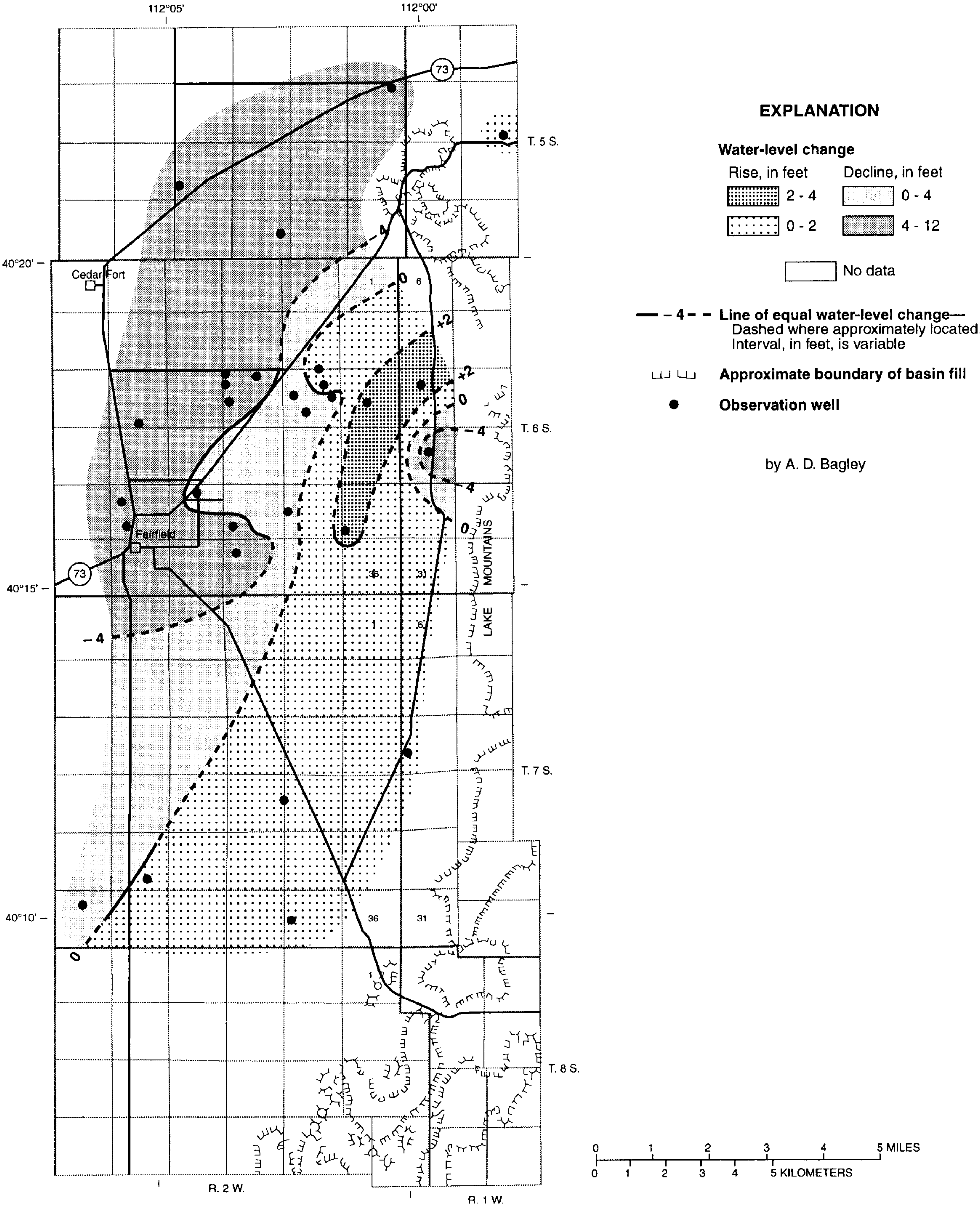


Figure 36. Map of Cedar Valley, Utah County, showing change of water levels from March 1989 to March 1994.

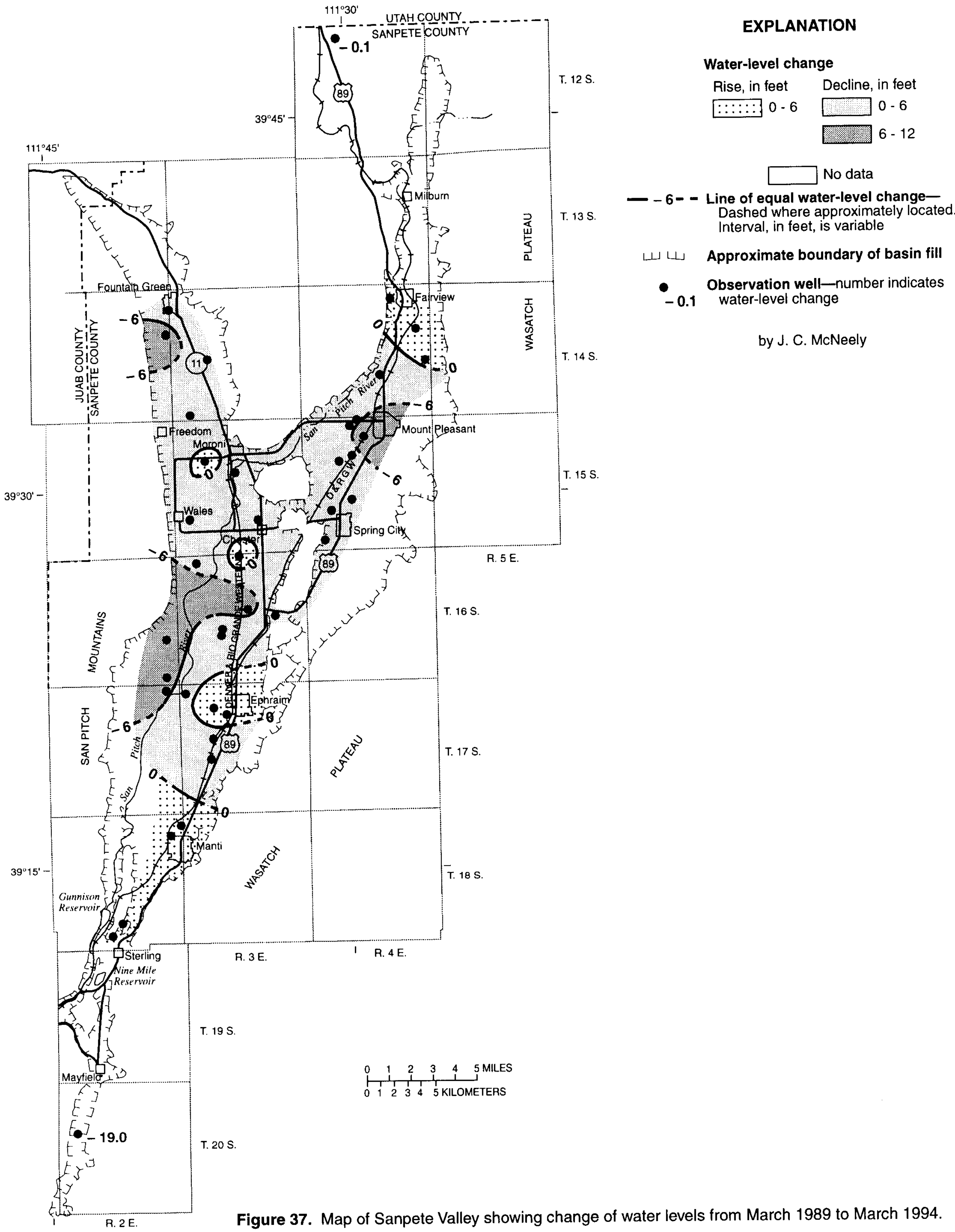


Figure 37. Map of Sanpete Valley showing change of water levels from March 1989 to March 1994.

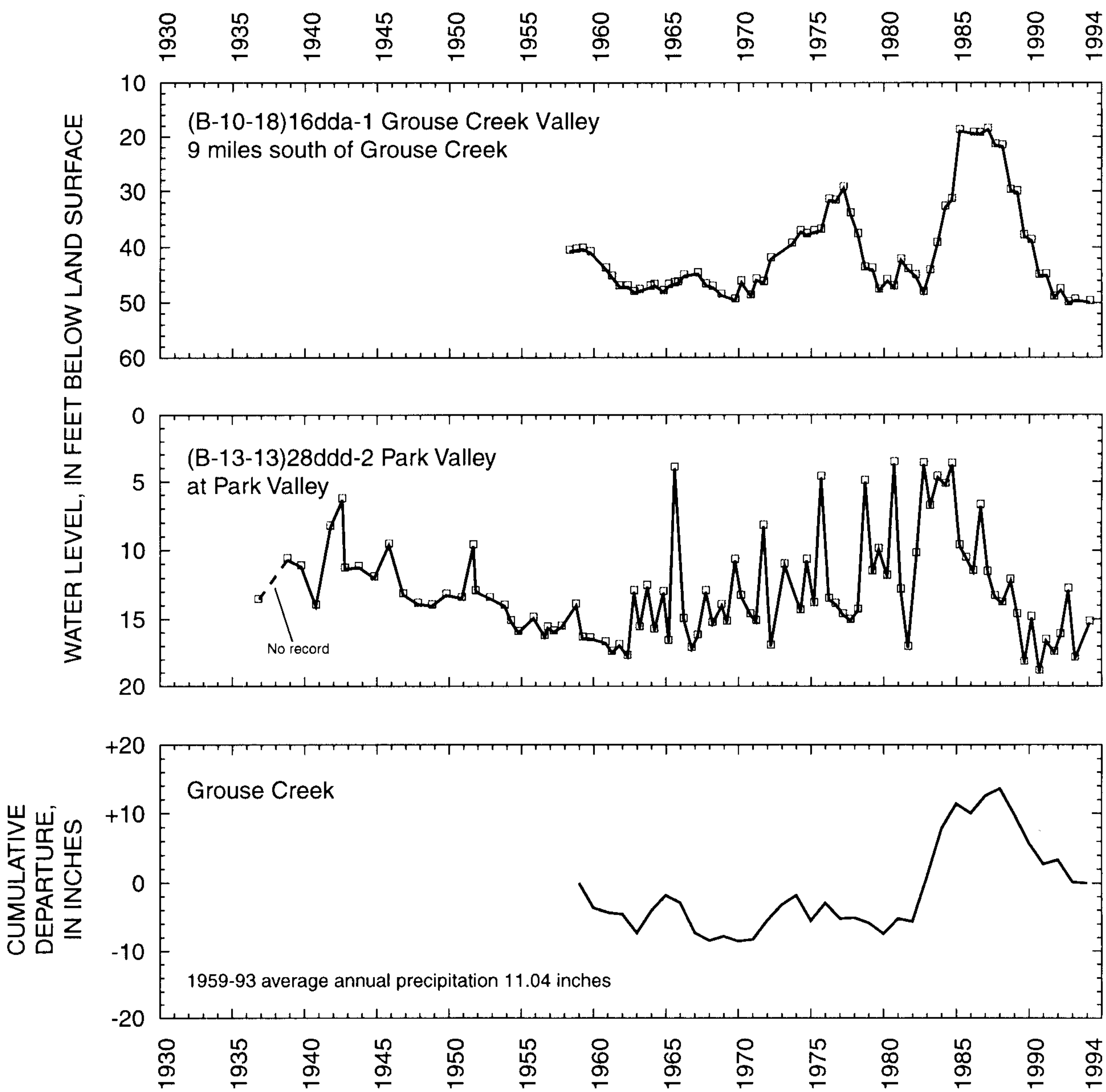


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas.

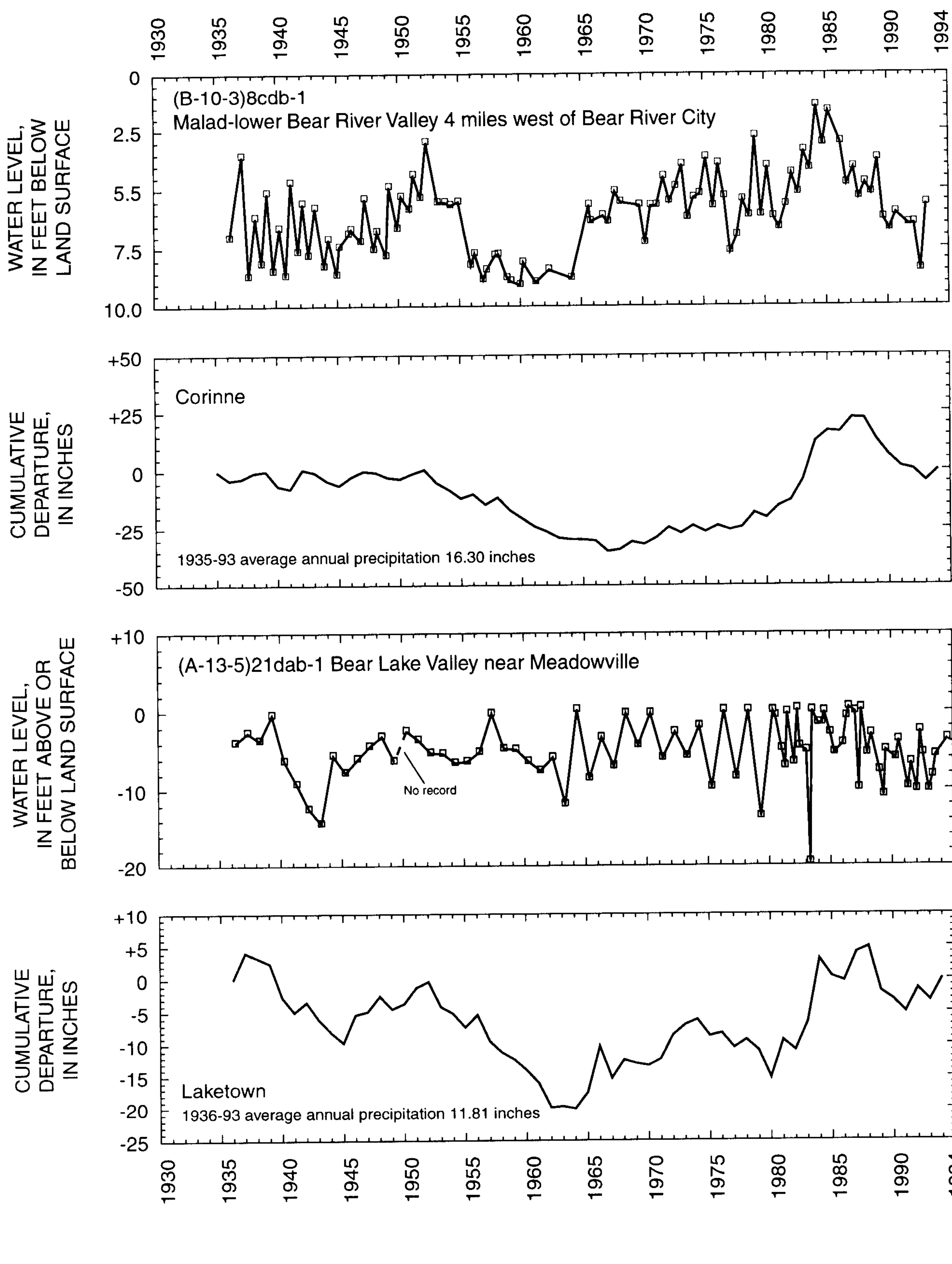


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

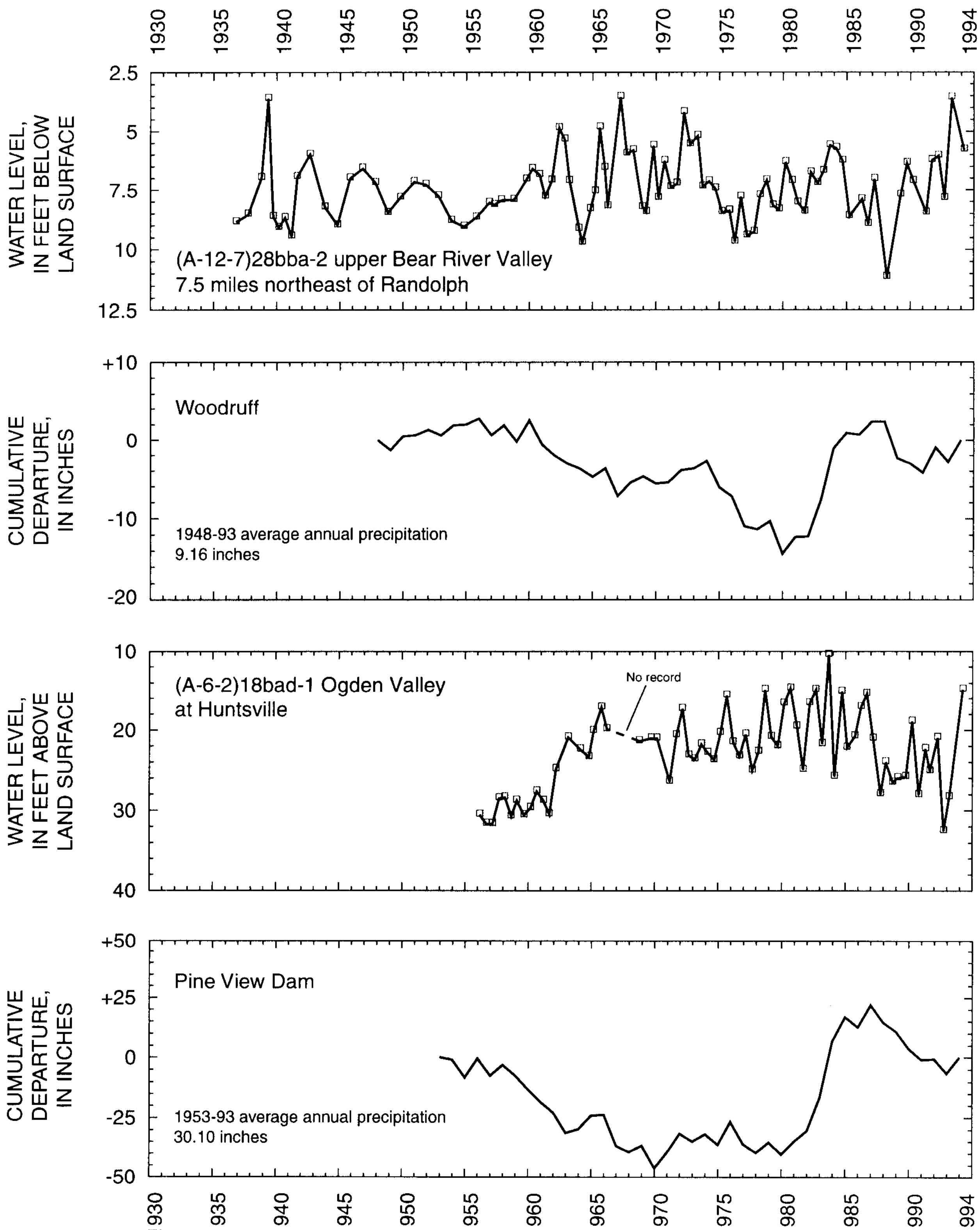


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

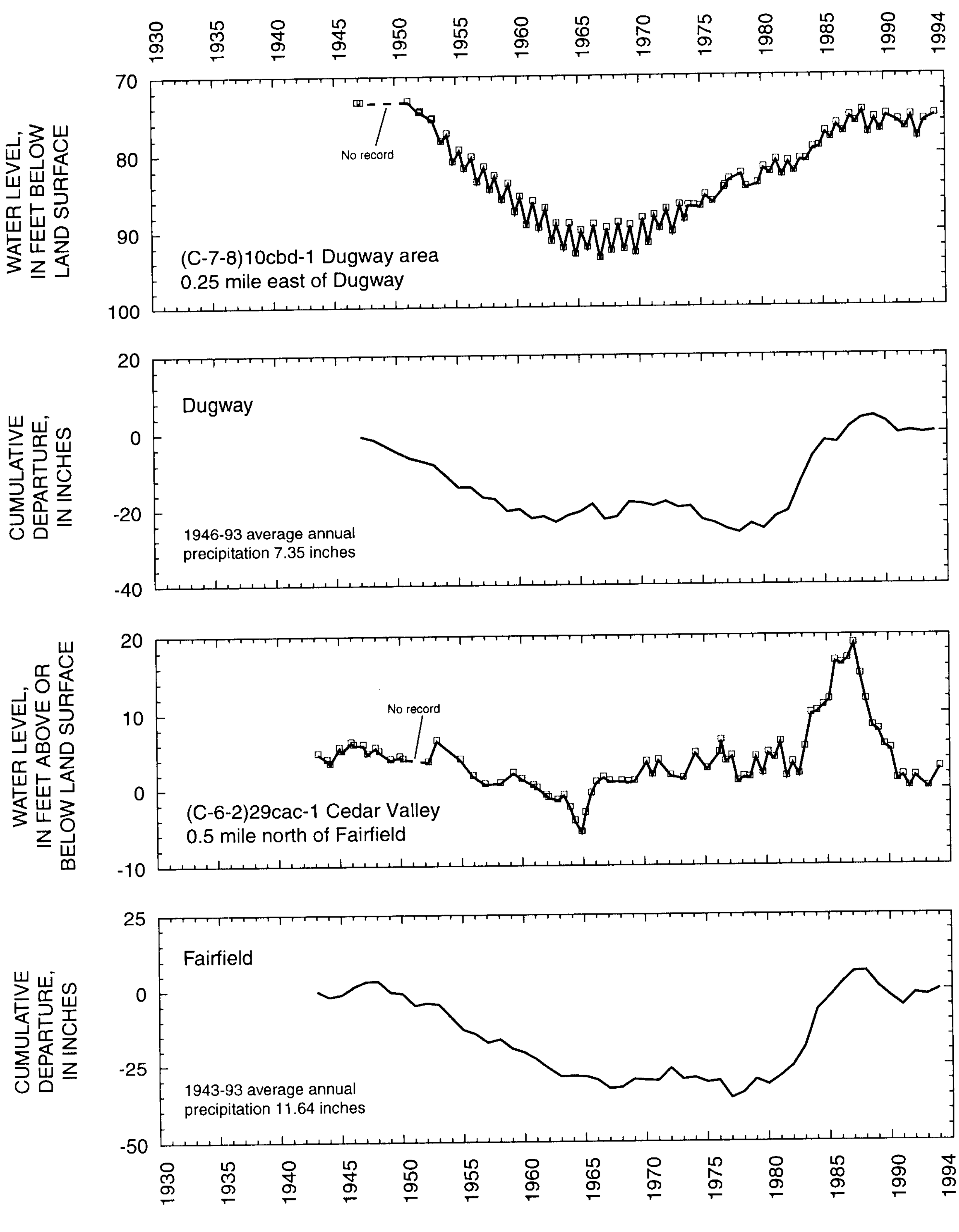


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

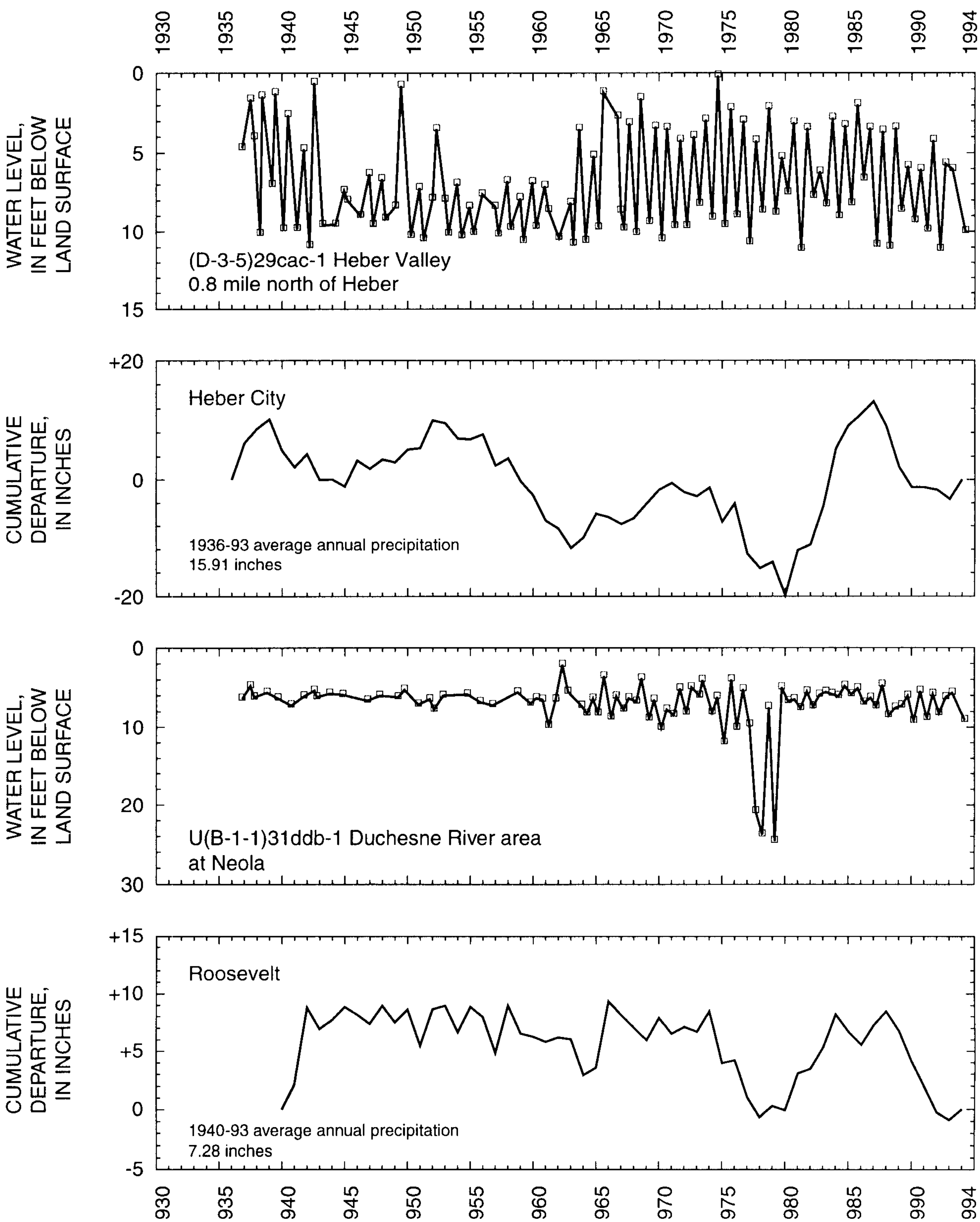


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

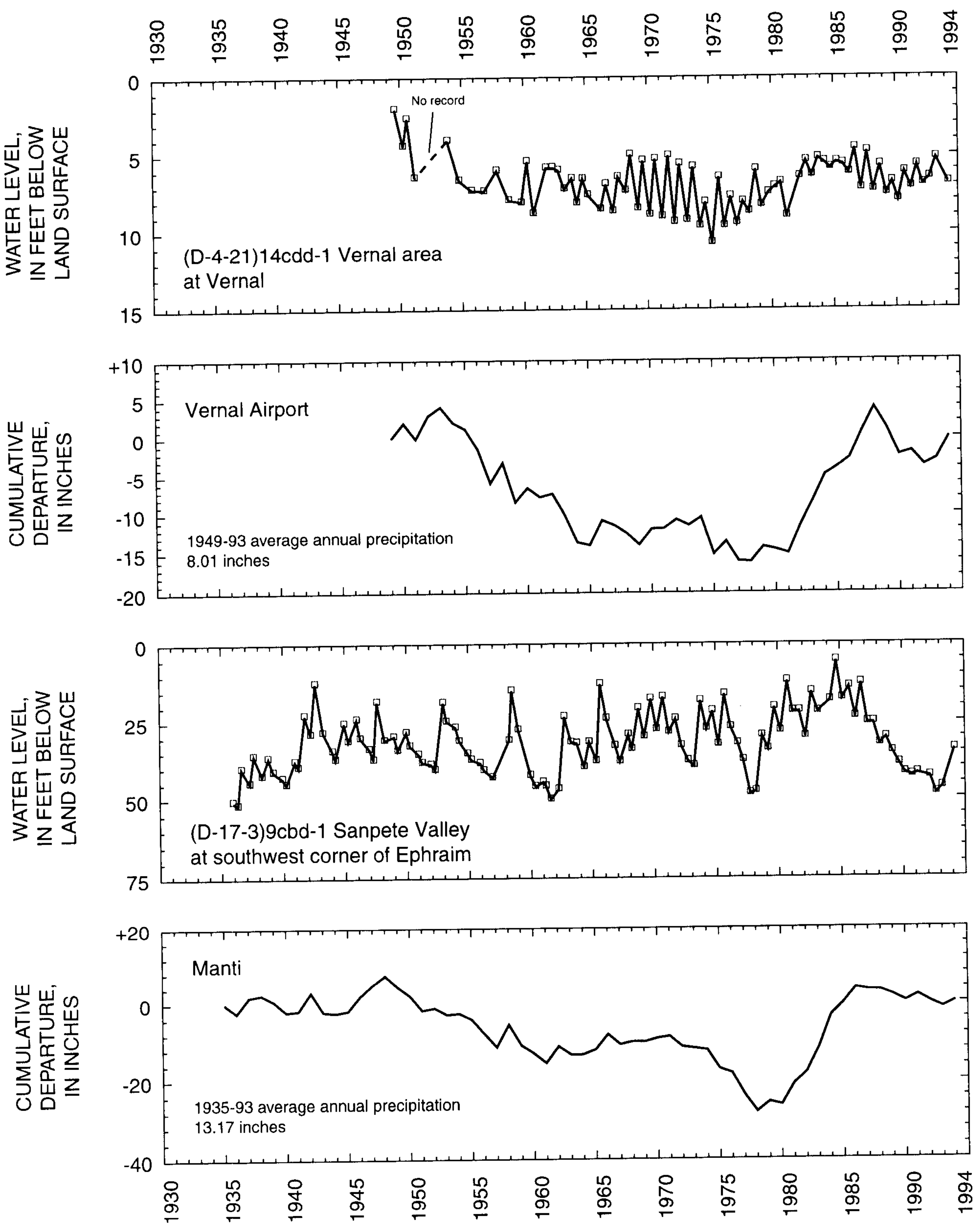


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

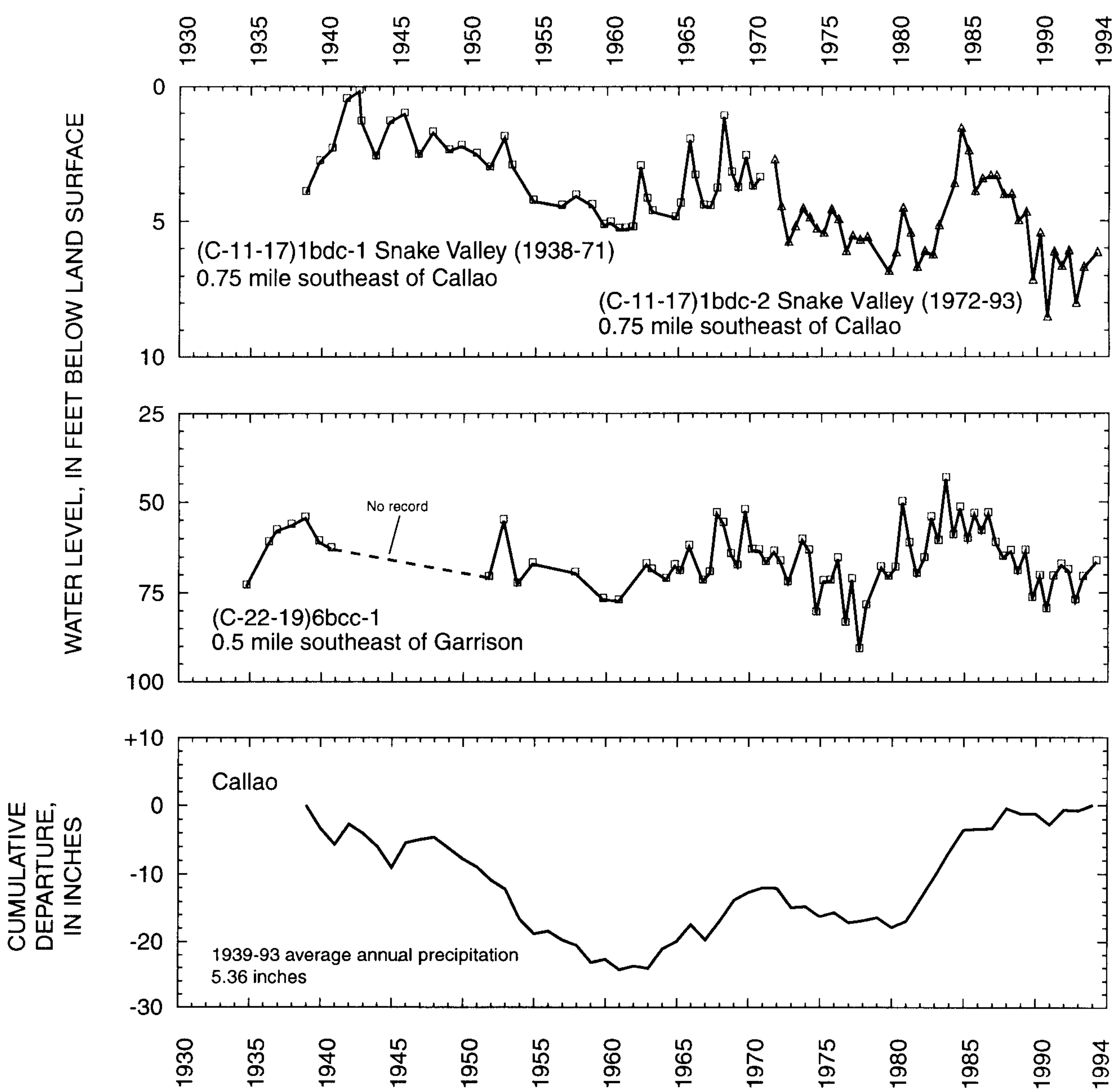


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

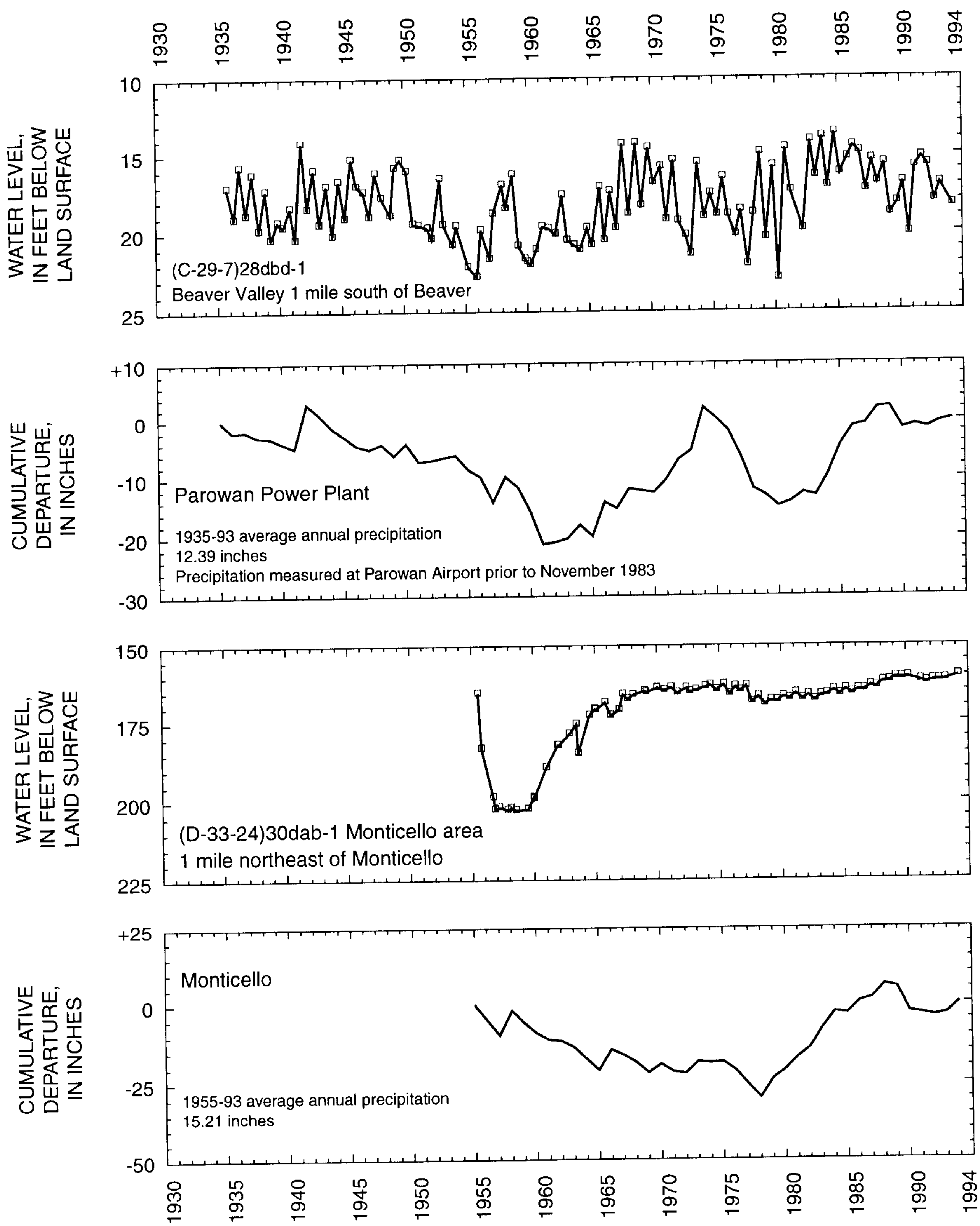


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

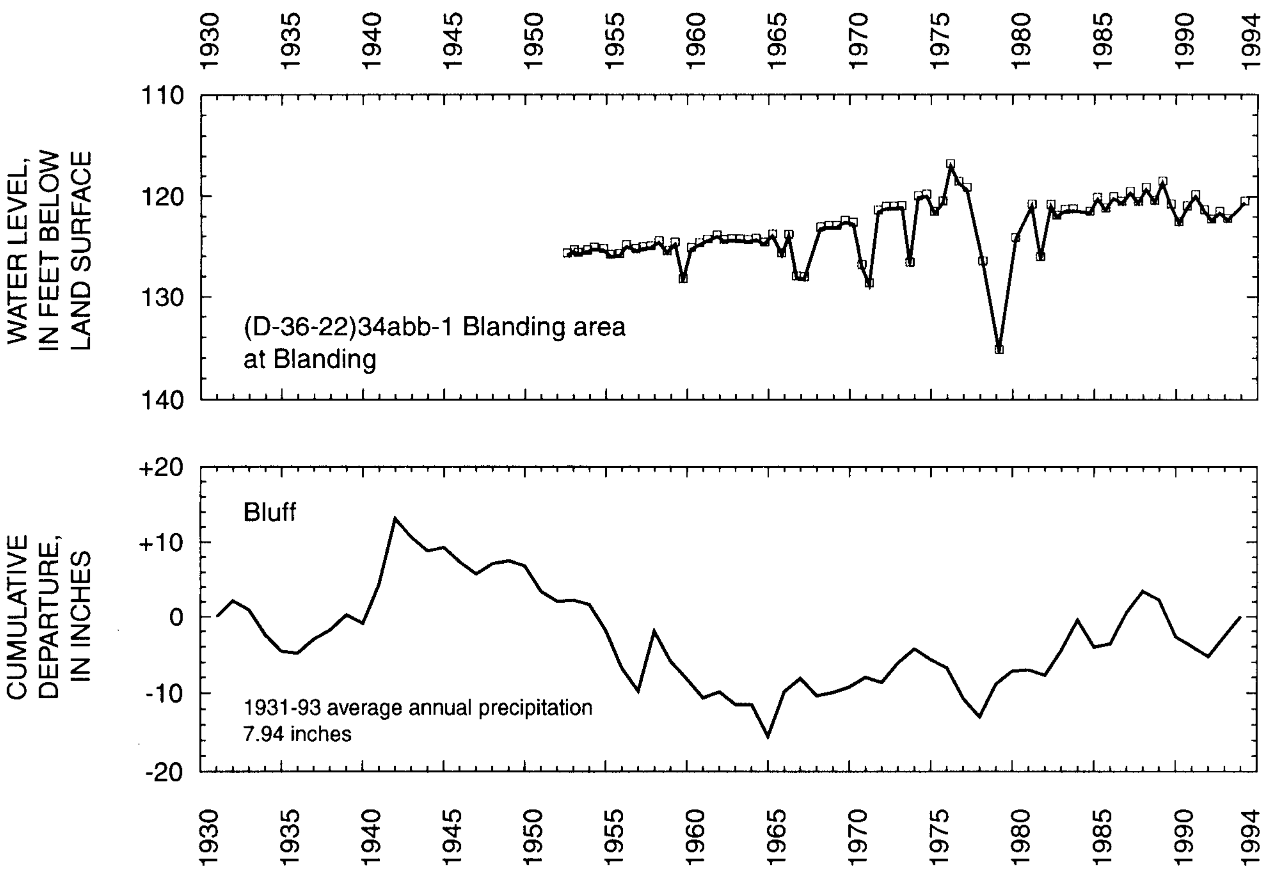


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

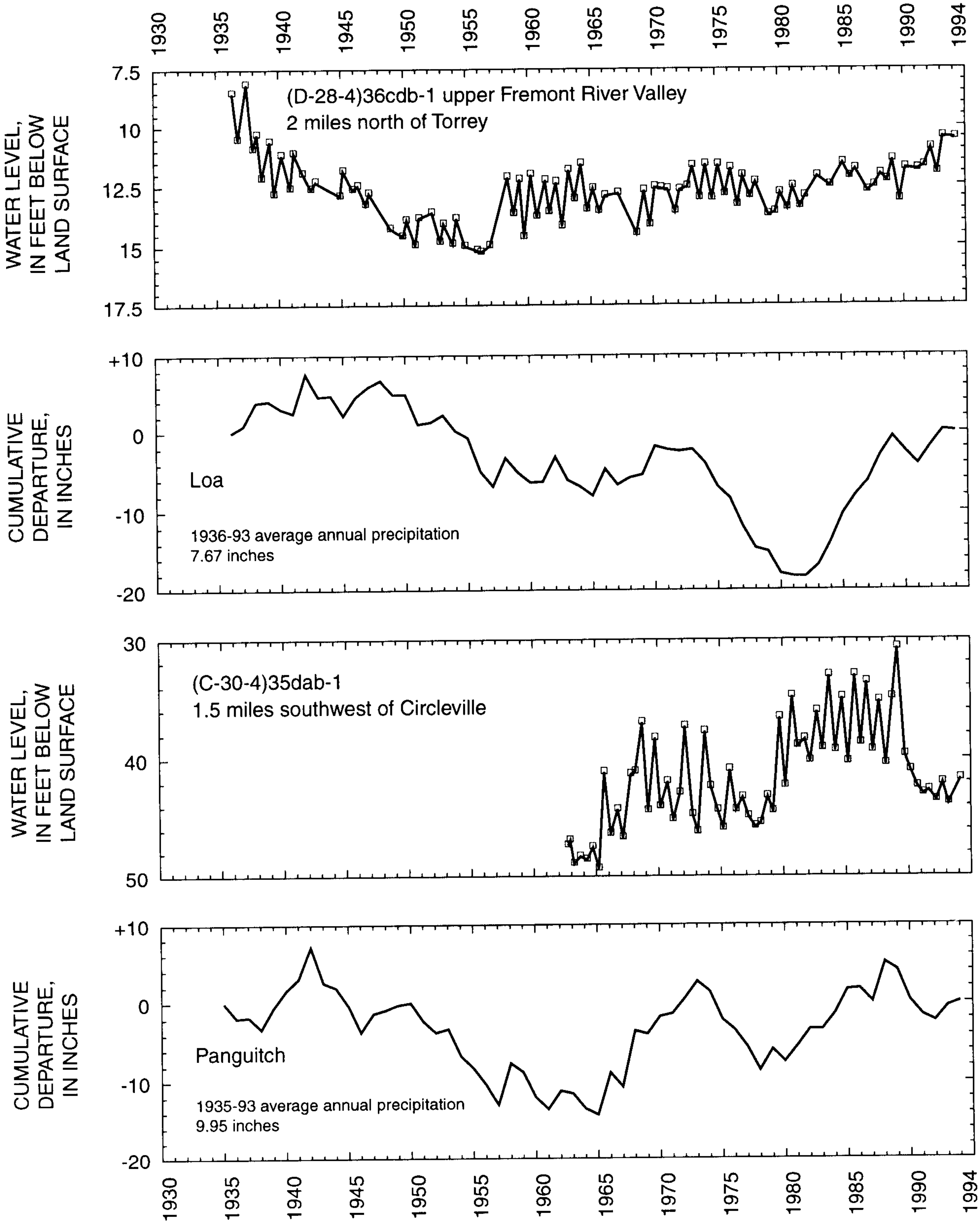


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

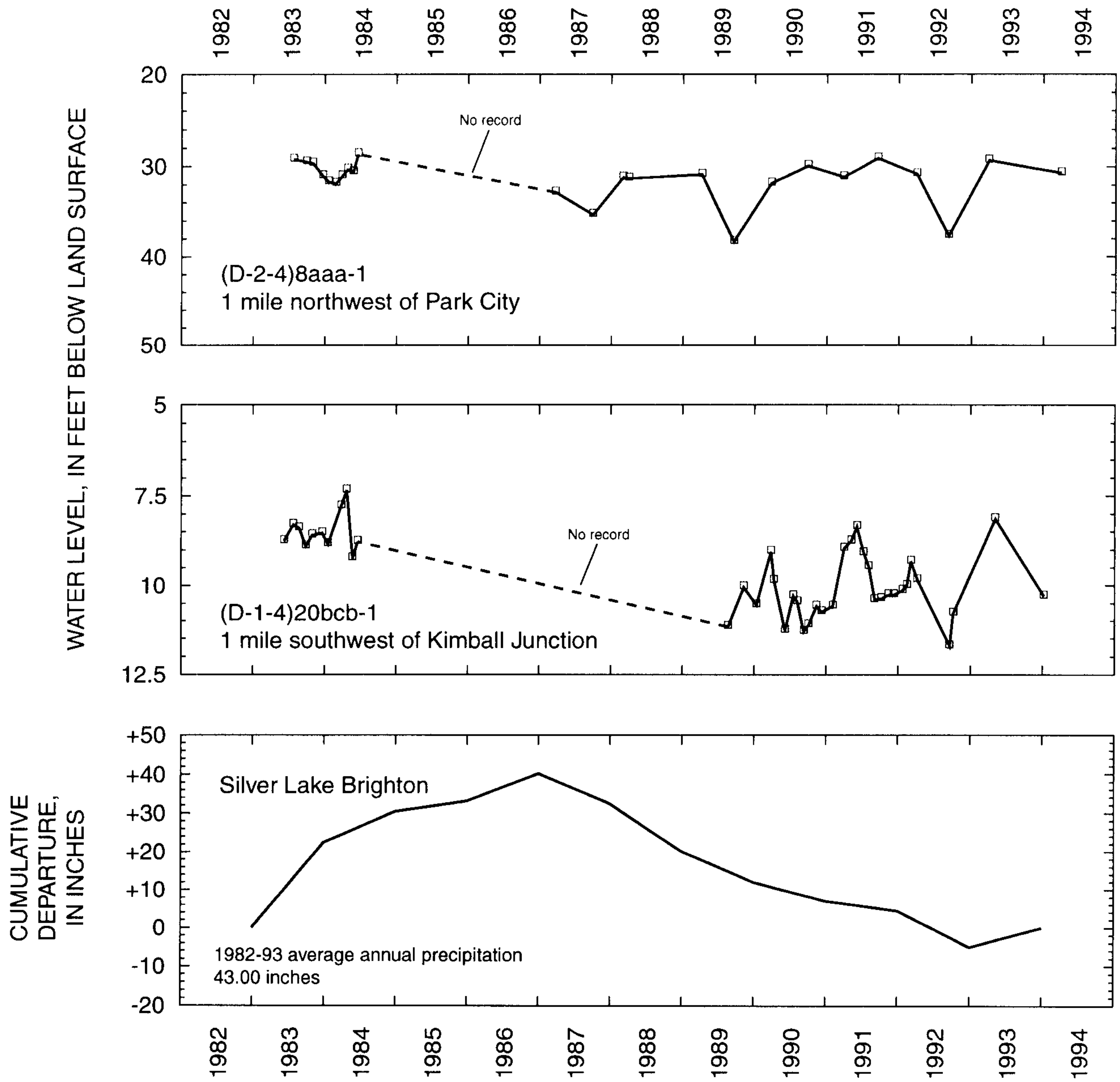


Figure 38. Relation of water levels in wells in selected areas of Utah to cumulative departure from the average annual precipitation at sites in or near those areas—Continued.

REFERENCES

Arnow, Ted, and others, 1965, Ground-water conditions in Utah, spring of 1965: Utah Division of Water Resources Cooperative Investigations Report No. 33, 99 p.

Batty, D. M., Allen, D.V., and others, 1993, Ground-water conditions in Utah, spring of 1993: Utah Division of Water Resources Cooperative Investigations Report No. 33, 106 p.

Handy, A.H., Mower, R.W., and Sandberg, G.W., 1969, Changes in chemical quality of ground water in three areas in the Great Basin, Utah, *in* Geological Survey Research, 1969: U.S. Geological Survey Professional Paper 650-D, p. D228-D234.

National Oceanic and Atmospheric Administration, 1993-94, Climatological data, Utah: Ashville, N.C., National Climatic Data Center, v. 95, no. 1-12, [variously paged].

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